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Practical Methods of Abating Smoke

By MR. J. M. SEARLE
Chief of the Division of Smoke Inspection of the City of Pittsburgh

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* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, NOVEMBER 22nd, 1912.

The meeting was called to order by the President, Mr. A. G. Mitchell, at the Monongahela House, Pittsburgh, Pa., at 8:15 o'clock P. M.

The following persons registered:

MEMBERS.

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Craig, E. M.
Crawford, D. F.
Crouch, A. W.
Cunningham, R. I.
Deckman, E. J.
Detwiler, U. G.
Drayer, U. S.
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Fitzgerald, D. W.
Gallinger, Geo. A.
Gies, Geo. E.
Gilg, H. F.
Glassburn, S. G.
Gowdy, H. K.
Gray, G. B.
Grimshaw, F. G.
Harriman, H. A.
Hilty, H. A.
Hoffman, C. T.
Holbrook, W. H.
Howe, H.
Hudson, W. L.
Hurley, Theo.
Kelly, H. B.
Keptner, J. B.
Kessler, H.
Kinch, L. E.
Knickerbocker, A. C.
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Millar, T. W.
Mensch, E. N.
McCleary, G. T.
McFeatters, F. R.
McGaughey, Chas.
McIlvaine, C. L.
McKee, S. F.
McNulty, F. M.
Newman, L. L.
Orner, Milton T. S.
Phillips, Lee
Postlethwaite, C. E.
Rabold, W. E.
Reymer, C. H.
Richardson, E. F.
Riley, T. J.

Redding, D. J.
Rohn, W. B.
Ryan, Wm. F.
Scheck, H. G.
Schomberg, W. T.
Schoonover, W. H.
Scott, W. M.
Sharpley, H. G.
Shook, A. A.
Shook, S. D.
Smith, John B.
Smith, Russell
Smith, M. A.
Smoot, W. D.
Snyder, F. I.
Snyder, Jos.
Spangler, C. P.
Steett, O. B.
Taylor, F. C.
Thurber, G. P.
Turner, L. H.
Walter, W. A.
Walther, G. C.
Walker, J. W.
Weiss, W. W.
Wescoe, F. V.
Williams, W. W.
Wood, Ralph C.
Wyke, J. W.

VISITORS.

Allen, H.
Anthony, J. T.
Bacon, R. F.
Byron, A. W.
Deihl, H. M.
Dickson, R. B.
Fanning, J. A.
Fitzgerald, E. A.
Gibson, Frank
Gillespie, W. J.
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Grieve, R. E.
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Laylin, M. H.
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O'Neil, J. P.
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Rainer, Ernest
Reynolds, I. H.
Sarver, G. E.
Sneck, H.
Sproul, H. V.
Stewart, E. C.

The minutes of the October meeting having been published, the reading of them was dispensed with.

The Secretary read the following list of applicants for membership:

Anthony, J. T., Rep. American Arch Co., 30 Church St., New York, N. Y. Proposed by J. B. Anderson.

Byron, A. W., Master Mechanic, Penna. R. R., S. S., Pittsburgh, Pa. Proposed by H. H. Maxfield.

Doty, W. H., Air Brake Inspector, Penna. R. R., Derry, Pa. Proposed by C. T. Hoffman.

Fitzgerald, H. M., Tariff Clerk, Penna. Lines West, 835 Fulton Bldg., Pittsburgh, Pa. Proposed by H. L. Higgins.

Gillespie, Wm. J., Boiler Inspector, P. & L. E. R. R., 1127 Charles St., McKees Rocks, Pa. Proposed by John B. Smith.

Gilbert, Alex. D., Clerk, Penna. R. R., 1104 Mulberry St., Wilkinsburg, Pa. Proposed by W. H. Sullivan.

Hair, H. J., Salesman, Manning, Maxwell & Moore, Inc., 1005 Park Bldg., Pittsburgh, Pa. Proposed by Robert A. Bole.

Higgins, R. I., General Round House Foreman, B. & O. R. R., Glenwood, Pa. Proposed by L. Finegan.

Howe, M. E., District Sales Manager, Glidden Varnish Co., 6073 Jenkins Arcade Bldg., Pittsburgh, Pa. Proposed by D. M. Howe.

Lee, F. H., General Car Foreman, B. & O. R. R., Glenwood, Pa. Proposed by L. Finegan.

Millar, H. A., Civil Engineer, John Eichleay, Jr., Co., 51 Rodgers Ave., Bellevue, Pa. Proposed by C. W. Millar.

Millar, R. J., Constructing Engineer, Chas. Bickel, Architect, 51 Rodgers Ave., Bellevue, Pa. Proposed by C. W. Millar.

Mitchell, A. F., Supt. Heat Treating Shop, Carnegie Steel Co., Homestead, Pa. Proposed by W. A. Buechner.

McAbee, W. S., Clerk, Union R. R., 208 Renova St., Pittsburgh, Pa. Proposed by A. F. Coulter.

McGinnes, B. P., Yard Master, Union R. R., 7716 Kelly St., Pittsburgh, Pa. Proposed by A. F. Coulter.

Newman, John F., Storekeeper, Penna. R. R., S. S., Pittsburgh, Pa. Proposed by L. E. Kinch.

Pehrson, A. K., Asst. Chief Draftsman, Pressed Steel Car Co., McKees Rocks, Pa. Proposed by C. W. Millar.

Richers, Geo. J., Motive Power Inspector, Penna. R. R., 245 South Pacific Ave., Pittsburgh, Pa. Proposed by W. H. Sullivan.

Rohn, Martin R., Asst. Car Distributor, Penna. R. R., 5802 Rippey St., Pittsburgh, Pa. Proposed by C. C. Clark.

Ross, S. S., Foreman Air Brake Dept., Penna. R. R., 536 Osceola St., Pittsburgh, Pa. Proposed by H. A. Hilty.

Spaeth, W. F., Asst. R. F. Eng., Penna. Lines West, 29 Main St., Carnegie, Pa. Proposed by W. H. Holbrook.

Wilson, Reah F., Supervisor, Penna. R. R., 201 Western Ave., Aspinwall, Pa. Proposed by F. W. Smith, Jr.

Williams, R. F., Salesman, Manning, Maxwell & Moore, Inc., 1005 Park Bldg., Pittsburgh, Pa. Proposed by Robert A. Bole.

PRESIDENT: As soon as these applications have been favorably passed upon by the Executive Committee, the gentlemen will become members.

SECRETARY: With regret I announce the death of Mr. M. A. Malloy, Master Mechanic, Monongahela Division, P. R. R. Mr. Malloy was elected into membership in this Club October 24th, 1902. He died suddenly of heart failure, November 3rd, 1912, near his home, 5423 Claybourne Street, East End, Pittsburgh.

PRESIDENT: An appropriate memorial minute on the death of Mr. Malloy will appear in the November issue of the Official Proceedings.

If there is no further business, we are ready to proceed with the discussion of the evening. The paper is entitled "Practical Methods of Abating Smoke," by Mr. J. M. Searle, Chief of the Division of Smoke Inspection of the City of Pittsburgh.

PRACTICAL METHODS OF ABATING SMOKE

BY MR. J. M. SEARLE, CHIEF OF THE DIVISION OF SMOKE INSPECTION, CITY OF PITTSBURGH, PA.

The question of fuel combustion is so large that justice cannot be done in writing about it, either to the fuel user or to the general public, in anything less than a volume of considerable proportions. And I might add that the City Smoke Inspector, or any one else for that matter, who engages to say something upon an occasion such as this, that may be considered the last word upon the question of practical smoke abatement, is indeed traversing dangerous ground. My little message tonight is not intended as such, but is rather for the purpose of opening the subject in a way that it is hoped will produce scientific and

helpful discussion upon this floor. As this is a railway club, and as I am a machinist and also a locomotive engineer of seven years' service in the days of single track and engines not yet pooled, I possibly don't feel as lonesome among you as I may look.

Dense black smoke issuing from a chimney or stack unfailingly indicates waste of fuel. It also as unfailingly indicates the emission of volumes of poisoned invisible gases, which not only filter into and poison the atmosphere which we breathe, but which also rob the plant from which they are emitted of a greater portion of the fuel than (for the same period of time) is being converted into heat-energy for useful work. And this condition, of course, refers to locomotives as well as stationary plants.

We have also the additional loss to the general public, caused by the unnecessarily rapid soiling of everything we wear or handle. Who will say that the smoke and grime caused by the imperfect combustion and consequent waste of fuel in our coal-burning furnaces in Pittsburgh does not add at least a dollar a month to the combined laundry and cleaning bills of each individual? And who has the hardihood to suggest that each of us does not pay another dollar a month to the dry goods merchant because of losses sustained in the rapid soiling of expensive fabrics which must not only be exposed to unnecessary soot on shelving and counters, but handled time and again by prospective purchasers?

A gentleman who has much in common with the management of one of the large dry goods establishments, of which we all have reason to be proud, replied somewhat indifferently to my inquiry upon this subject: "Yes, Pittsburgh smoke costs us from 10 to 20 per cent. per annum, but we don't wish you to understand that we are registering a kick. You pay the smoke bills when you purchase."

If the above estimates are approximately correct, and I believe they are ultra-conservative, we, in Greater Pittsburgh, have an annual waste of say three to five millions of dollars in these items alone. One of our largest retail houses has placed the loss from smoke at 20 per cent. I believe this is more nearly correct, and I ought to be a good judge because of my close study of the problem for many years.

It is impossible to honestly champion the cause of smoking

chimneys or stacks today, unless such championship is the product of sheer ignorance of even the rudiments of the science of combustion.

What better proof of the fact do we need or can we have that smokeless combustion of Pittsburgh coal is a paying proposition than that approximately thirty thousand (30,000) horse power of the boilers used by the coal mining companies in this district are equipped with the best and most nearly smokeless mechanical stokers known, and that orders are continually being placed by these companies for smokeless equipments for their boiler plants at the mines? If it pays to burn coal smokelessly at the pit mouth, where fuel costs thirty cents a ton, then is it not a still better proposition where freights must be added, which in many instances more than double the cost of the fuel to the consumer?

As to the progress being made toward the ideal condition in Pittsburgh, the work for betterment of the smoke conditions has gone on apace. The present administration has secured smoke abatements approximating ninety-five per cent. in some sixteen hundred instances, and abatements to some appreciable extent in something over a thousand additional instances.

The railroads entering the city are doing much to reduce the smoke issuing from their locomotives. In some instances coke is being used as fuel while locomotives are passing through the city, and in many others devices such as the brick arch and underfeed stoker, which reduce the smoke appreciably, or wholly, are in use.

In working out the problem of smoke abatement for the locomotives of their systems, the railroads have, during the past seven years, not only spent large sums of money experimenting on their various divisions, but in addition to this the Pennsylvania Company have sent a committee of experts abroad for the purpose of studying smoke conditions on the Continent and in England. This committee paid special attention to conditions in London, Berlin and Paris. They traveled a great many thousand miles and stopped at every point where information could be expected. After studying their report and noting the average quality of fuel used abroad, it would seem that our American railroads are undoubtedly far ahead at this time in solving the

problem of smoke abatement for locomotives burning such highly volatile bituminous coal as we find in the Pittsburgh district.

Probably the most important development in connection with the abatement of smoke in the past few years has been that of the locomotive stoker. From a viewpoint of one not familiar with the detail of locomotive construction and operation, it will probably seem that the development of a locomotive stoker along the lines of well-known stationary practice would be very simple, but when one takes into consideration the limited space available for the application of the stoker to a locomotive, the variation in load, which is from zero to 100 pounds or more fuel per square foot of grate area, and the limited space for the construction of the conveyor to convey the coal from the tender to the locomotive proper, and the mechanical abuse that the stoker is subjected to when the machine is run at high speeds, it becomes evident that the field of the locomotive stoker is distinct from that of the stoker which is successful in stationary service.

The locomotive stoker is now a practical firing machine, after many years of continual experiments in which the railroads have spent large sums of money and a vast amount of patience with unwavering effort.

Of course, each class of locomotives in each class of service requires different treatment, necessitating a large amount of work in the development of the machine for the various service to be met. It is evident that in developing the locomotive stoker, we must meet the following conditions, or failure will result:

1. We must have a machine capable of generating sufficient steam under all conditions of train lading and speed.

2. A device to burn the fuel in an efficient manner and in so doing provide a material reduction in the smoke.

3. The device to be so constructed that it would form a part of the locomotive itself and not a temporary attachment subjected to the whims of the operator.

4. That in the application of the stoker no obstructions should be placed in the way of the fireman as far as access to the coal on the tender or to the fire door in the boiler for properly hand-firing the locomotive, either in combination with the stoker or with the stoker entirely inoperative.

5. That the device should be of such character that its maintenance cost would be low and that it be simple in operation

in order to avoid any additional work upon the fireman in operating it.

While the outlook toward smokeless locomotives for Pittsburgh during the year 1912 is very much improved, in fact is better than at any previous date, the same applies to the mills and factories which are always with us. Our office files, and the stacks and chimneys of our city plants and locomotives, for 1912 show a marked improvement in smoke abatement over 1911, and judging from what data we now have for prospective equipments for 1913, the total number for the year 1913 will be greater than that of the smokeless installations made during the year 1912, and this changed condition is largely due to the fact that owners and operators have awakened to the fact that it does not pay to operate with smoky stacks.

An instance of labor and fuel saving too important to pass by at this time without mention came to my notice only last week. An old plant of 55 boilers had become worn out. The insurance company had cut the pressure to 85 pounds; the mill was loaded down with orders. It was concluded, as a last resort, to find a place to locate an up-to-date plant of boilers and double the steam pressure. Eight 600-horse-power units of the water-tube type fitted with good mechanical stokers were installed. These eight new boilers are saving in pay roll $1,500 per month, and in coal $3,500 per month, which, as you will note, is $60,000 per annum, or six per cent. on one million dollars. But they have done much more than this; they have increased the capacity of the entire mill, which increase is an additional source of revenue, and they occupy but 4,500 square feet of ground, whereas the 55 boilers which were thrown out occupied 45,000 square feet, which turns loose 40,500 square feet of most valuable ground for purposes of mill enlargement.

It so happened that an evaporative test was being conducted upon one of these 600-horse-power units the day the writer last visited this plant, and an average capacity of 948 horse-power had been developed for about six hours. The eight individual stacks were absolutely smokeless and the products of combustion had averaged for this six-hour period 12% of Co-2 gas. This plant, that is saving the interest at 6% on $1,000,000, cost complete but $130,000, including steel boiler house, main steam piping, feed pumps, Cochran heaters, ash and coal handling devices, the later being for both river and rail.

Can better reasons or stronger argument be produced for the erection of modern boiler plants than is shown by the books of the Crucible Steel Company, from which I have just quoted and which refer to three months' operation of their new boiler plant between 30th and 31st Streets, this city?

In designing a boiler plant, we must not forget that no one device, appliance, or method will suit all conditions. The smoke evil does not take more kindly to a universal "cure-all" than does the human system. On the contrary, each case of smoke abatement must receive individual attention.

When the stoker salesman approaches the manager he is frequently met with the statement that the coal bill is, relatively speaking, a small item. If he knows his job he will immediately begin to convince Mr. Manager that the dollar saved by the fireman has just exactly the same value as the dollar saved by the purchasing agent, and that the treasurer likes it just as well, and that a dollar is a dollar and always looks the same in the dividends wherever you find it. Managers in our city of Pittsburgh are just now being importuned not to make expensive alterations to their power plants because large central stations, distant several miles from this city, are nearing completion, which will supply power cheaper than we can ever hope to produce it in our small local plants. It is, therefore, up to us, I believe, at this moment to give them a run for their money, and in doing this we cannot longer neglect the coal pile. Neither must we ever permit ourselves to believe that the small power plant cannot produce as cheaply as the large plant. The central station makes power to sell and the small plant makes it for home consumption, and, as usual, the farmer's family has the small potatoes, for up to this time they have been considered good enough for the people at home. We must now commence to eat the big potatoes because bookkeeping in the power plant is commencing to force economies. We are now all looking for leaks. Then, too, the general tendency of the price of coal for many years has been upward. We must expect this tendency to continue, because there is less coal in the field today than there was yesterday, and more furnaces each succeeding day to consume it. We must, therefore, in view of all these things, attack the fuel problem and attack it now.

A certain manager sent his fireman to jail for stealing a few

hods of coal. A few months later an economy expert showed this same manager how he could save 20% of his coal at a very small expenditure. He never budged; he was concerned more in the manner of the loss than the cost of it. There are too many such managers. Too many of them prefer to continue paying the cost of the same needed improvements each year rather than invest the amount so wasted in improvements that would at once stop such payments and commence to increase dividends at home, and at the same time render their plant a real joy rather than a continual nuisance to their neighborhood or community. It must not be understood, however, that the installation of a good mechanical stoker is the last word in boiler room economy or smokeless combustion, for such is not true. We also need some reliable form of Co-2 recorder, also our pyrometer and differential draught-gauge must constantly point to results, if we expect to produce high furnace efficiency and smokeless plants. In boiler practice, the arrangement and relative position of the absorbing surfaces has much to do with plant efficiency. Then, too, the nature of the load carried must always be considered when selecting our machine-firing device. And we must not expect too much of the man in front of the boilers, whom we pay from $1.75 to $2.50 per day. We must not expect such a man to understand the chemistry of the furnace. If we do, we will suffer disappointment, for when he has cleared the cobwebs from his brain sufficiently to appreciate the difference between the value of C-o and Co-2 gas as heat producers he will have a better job. No, you must place a practically fool-proof "machine fireman" in the hands of the average boiler house coal handler, and instruct him to call the engineer when trouble appears, if you expect to conserve your coal pile and produce high furnace efficiency and a smokeless stack. As time passes, your fireman will perhaps call the engineer less frequently, and finally he will understand and care for the machine himself, but not so at first.

We have, as engineers, spent much thought and much money on compounding high-class reciprocating stationary engines and locomotives and in designing many types of steam turbines in order to grab the last unit of energy from the steam we have generated, but in far too many instances we have simply closed our eyes to the *appalling waste* of energy that is constantly sneaking dividends out of our stacks.

It is still considered quite the proper thing by many of our plant engineers to refer all ills in the boiler house to an evaporative test that records the amount of coal used and water evaporated, but without any reference to gas analysis. When such a test has been completed, the engineer gathers up his data and proceeds to figure out, as he says, the efficiency of his plant, without a scrap of data as to the composition of his products of combustion. Does he get much information of value from such a test? Well, not very much. He has commenced at the wrong end of his job. He should have first gone on a hunt for his percentage of Co-2 in his furnace products at the breeching. When he had finally determined this, and had brought it up to his liking, would have been time enough to hunt for the efficiency of his boiler. Don't commence at the top to run an efficiency test in a boiler house. Commence at the coal pile and go up, if you are really looking for results. If more boiler tests were commenced at the coal pile, carried through the furnace and breeching, and finally to the absorbing surfaces, instead of beginning at the absorbing surfaces, more data of value would be on record and more smokeless stacks would exist, for, after all, the last word in smoke prevention with our high volatile coals is and must remain at least 12 to 14 per cent. of Co-2 gas in our products of the furnace, whether such furnace may be for metallurgical, stationary or locomotive purposes. And while 14% of Co-2 at the breeching only indicates a surplus of 50% of air, our average Pittsburgh practice at our remaining smoky hand-fired plants shows about 5% of Co-2 at the breeching, and indicates surplus air up to about 177%, or 127% more air than we can use, taken into the furnace at say 65° Fahrenheit, and raised to the temperature of combustion, seemingly for no other purpose than that of robbing the absorbing surfaces of the boiler of an appalling percentage of the heat energy given up by the fuel.

It has been said that the phrase "smoke consumer" is not scientific and that it should not be used, and that smoke once formed could not be consumed. I wish to make it plain here that while I have much respect for the memory of C. Wye Williams and his valued records of research upon the lines of combustion, I cannot agree with him in this particular instance. What is this thing we are prone to call black smoke? What makes it black? Is it not carbon passing into the stack at a temperature so low

as to form what we call soot? If it is carbon, and I believe we will all agree that it principally is, what must we do to burn it and convert it into the invisible, harmless, heat-producing gas called carbon dioxide, Co-2? The answer is among the easiest of those that are required of the combustion engineer today. Supply two volumes of oxygen to each volume of carbon and the ordinary temperature that should obtain in any combustion chamber under any boiler or in any metallurgical furnace, and so arrange your combustion chamber as to force as nearly perfect contact of your oxygen and your carbon particles as may be found practicable, and your soot will never, never, get through that combustion chamber, no matter how dense and black it passes over the bridge wall.

Let us not quibble longer as to the phrases commonly used, both are correct. But some may ask, how are we to know when we have the correct, or approximately correct, volume of air? *First*, and accurately, by the use of a good Co-2 recorder. *Second*, and approximately, by the intelligent and occasional observation of the top of your stack. Never (when you are not using a Co-2 recorder) let the top of your stack run absolutely clear, if you expect the best *average* efficiency from your furnace. Carry a haze at your chimney top equal to about 1/10 of No. 1 "Ringlemann", and you will be sure of having a high average percentage of Co-2 in your products of combustion. If, on the other hand, you have no combustion recorder to guide you, and you are running an absolutely clear stack, your surplus air may not only be enough but it may be many times more than is required for high furnace efficiency. And while a practically smokeless stack always *accompanies* high furnace efficiency, on the contrary, as you have seen, a smokeless stack does not always *indicate* such efficiency.

The greatest difficulty in burning bituminous coal smokelessly and with high furnace efficiency lies in the fact that it burns partly as a solid and partly as a gas, and that the gas must be burned in a time much shorter than is required to burn the solids. It may be of interest to note here that 100 analyses recently made by this city have shown that an *average* of 42 3/10% of the total heat developed by our average Pittsburgh coal is contained in the volatile combustibles, and that for the combustion of this hydro-carbon content a fixed portion of our total air sup-

ply is required over the fire. After some thirteen years, during which I have been constantly in touch with the steam engineers of Pittsburgh, I feel safe in offering the suggestion that these last two conditions are not given the careful consideration that is bestowed upon other details of plant operation. In other words, the adequate supply of oxygen over the fire at the moment when something like 40% of our gaseous and extremely valuable hydro-carbons are being distilled is rarely, if ever, present. In fact, very few plant engineers dig down into the science of the question at all. If they did, the thought would quickly occur to them that we get no smoke from the solids in the fuel (the coke), therefore we must get it, if at all, from the volatile constituents, and if these contain fuel to any appreciable extent, we had better get busy and convert this fuel into useful energy. When the careful engineer visits a power plant in some one of our good city buildings or mills and notes the perfect order and organization in the engine room, including expensive compound condensing engines, and then remembering that the boiler stacks issue excessive volumes of smoke, it must indeed, to use a homely phrase, suggest "saving at the spigot and wasting at the bung hole."

While the brick arch in the firebox and the application of the steam jet to induce a volume of air over the fire both have a useful but somewhat limited field in present locomotive practice, and while round-house smoke constitutes one of our greatest nuisances, I have purposely refrained from commenting upon either, at this time, because discussion is desirable and my paper has already grown too long.

Before commencing to explain the pictures that will be thrown on the screen, I wish to illustrate graphically the necessity for a supply of oxygen over the fire, as well as through the grates. I have here a student lamp. This lamp has two sources of air supply, one under and one over the fuel; the fuel is kerosene (hydro-carbon). The chimney supplies the necessary draught to start the air current toward the fuel. The reduced diameter of chimney just above the fuel supply is the mixer. I know of no better illustration of a scientifically constructed furnace than this little lamp. And what I wish to make clear by this demonstration is the fact that we *must* bring oxygen in sufficient quantity into intimate contact with the hydro-carbons of our fuel the moment they are distilled, or our combustion will only be partial in-

stead of complete. And that a sufficiently hot combustion chamber will rapidly follow the proper proportion and mixture of the oxygen and hydro-carbon gases, and a high content of Co-2 together with practically smokeless results will always prevail under such conditions.

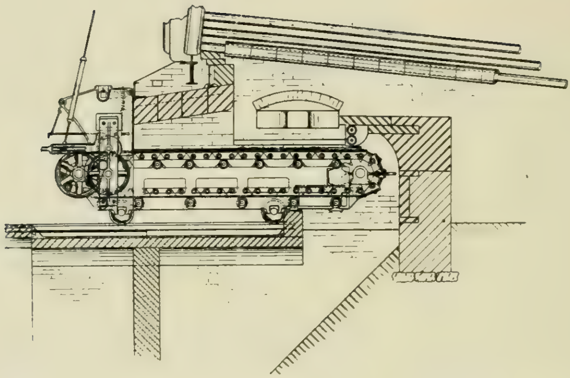
This brings rather forcibly to our vision, it seems to me, the antiquated but somewhat popular fallacy that a slight opening of the fire door and blower at times when the throttle is shut off on the locomotive is disastrous to flues and stay-bolts.

Placing the fire door on the latch and opening the blower just sufficiently to induce the necessary air over the fire so that somewhat better combustion of the hydro-carbons will result the moment the exhaust ceases to induce sufficient air into the fire through the grates tends to sustain rather than retard combustion, and when we do this rather than permit the hydro-carbons to cool and flow out of the stack as coloring for an accompanying volume of invisible but heat-producing C-o gas, we have not only eliminated a nuisance but we have gained heat energy for useful work, and when we have done this we have at the same time increased the efficiency and temperature of our fire box rather than lowered it by converting much of this C-o gas into Co-2. Not an absolutely clear stack, but just the slightest haze will indicate the proper condition in locomotive practice, for if our stack is absolutely clear we may have far more air flowing in at the fire door than is required for best results, whereas, a slight haze at the top of stack indicates nearly complete combustion and a temperature in the fire-box approaching the ideal, and we should all strive for that near approach, as by such we not only coin dollars for our employes, but each one of us help to a bate a serious nuisance as well.

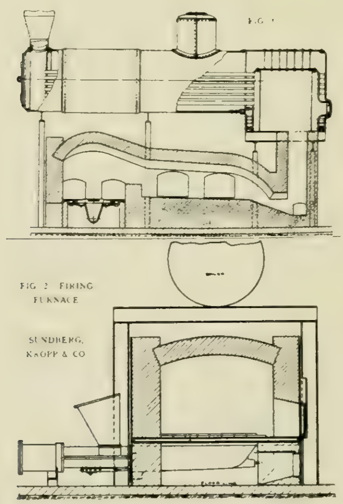
Weight of Air Per Pound of Combustible as Indicated by the Percentage of Co_2 in the Flue Gas

Per Cent. of CO_2	Pounds of Air	Per Cent. of CO_2	Pounds of Air	Per Cent. of CO_2	Pounds of Air
21	12	14	18	7	36
20	12.6	13	19.4	6	42
19	13.3	12	21	5	50.5
18	14	11	22.9	4	63
17	14.8	10	25.2	3	84
16	15.7	9	28	2	126
15	16.8	8	31.5	1	210

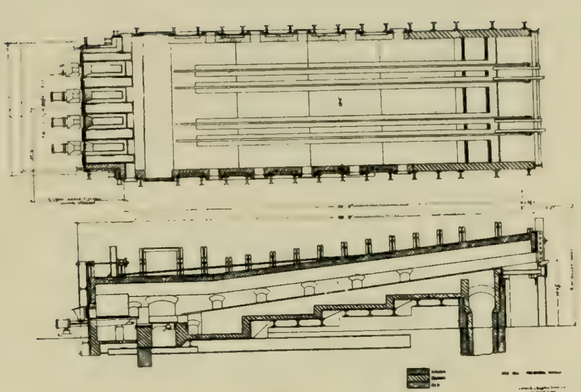
No. 1—Table showing weight of air per pound of combustible, as indicated by the percentage of Co-2 in the flue gas.



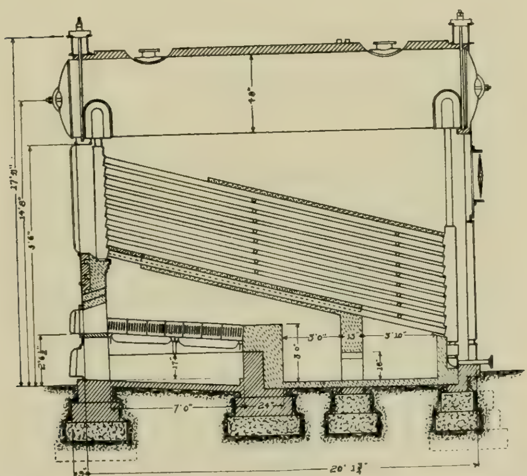
No. 2—Application of chain-grate stoker to water-tube boiler.



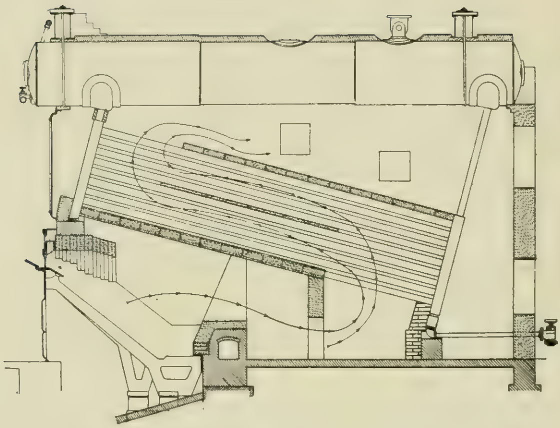
No. 3—Application of underfeed stoker to billet-heating furnace, showing waste-heat boiler above.



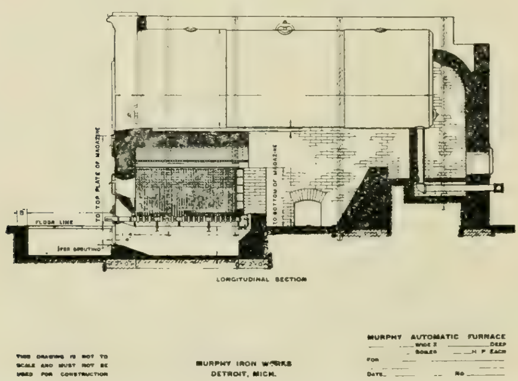
No. 4—Large metallurgical furnace equipped with four underfeed stokers, stack guaranteed smokeless when burning 4,000 pounds of coal per hour.



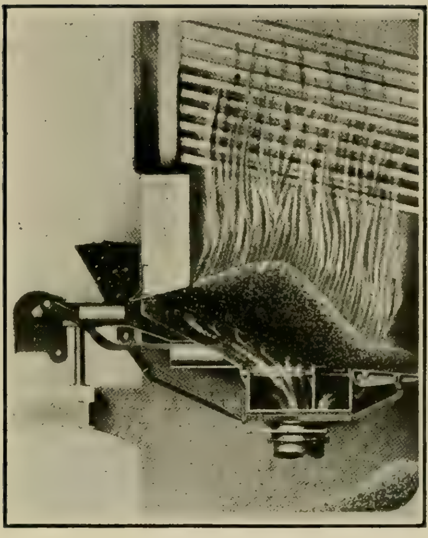
No. 5—Method of smokeless hand-firing under water-tube boiler.



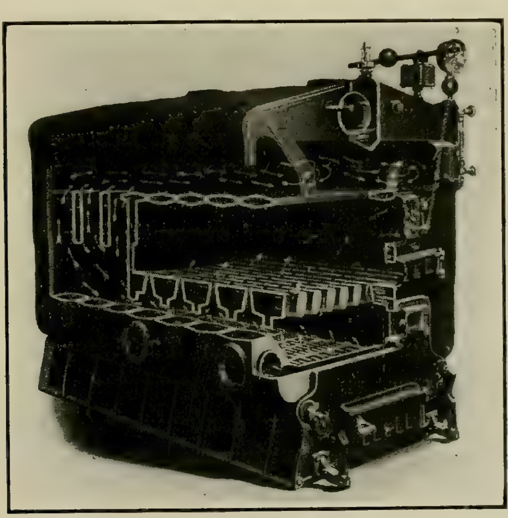
No. 6—Smokeless setting of furnace and boiler in the Frick Building, Pittsburgh, Pa.



No. 7—Example of side-feed mechanical stoker under horizontal tubular boiler.



No. 8—Taylor underfeed stoker installed under water-tube boiler.



No. 9—Smokeless low-pressure down-draft boiler for apartments and office buildings.

PRESIDENT: This is an exceedingly interesting subject and we would like to have a general discussion of it. I will call first upon Mr. D. F. Crawford, General Superintendent of Motive Power of the Lines West, the inventor of the Crawford Stoker.

MR. D. F. CRAWFORD: Mr. President and Gentlemen:—I want personally to thank the speaker for a very excellent paper on a very interesting subject, and also congratulate The Railway Club of Pittsburgh on having the opportunity to listen to it. It is most instructive and has told us a great many things we ought to know about combustion. It is something that we are indeed very much interested in, from two sides: First, the economic. (Probably Mr. Searle would put the second first.) And second, smoke prevention. There seems to be no question as to the desirability from all view points of providing mechanical feed for stationary boilers. I am quite satisfied from my own observation and from the observation of the Smoke Committee in Chicago, of which I am a member, and from some smoke observations in the city of Cleveland, that at least 60% of the smoke in our city is made by stationary boilers, and the treatment of stationary boilers, as Mr. Searle has pointed out, is very simple. It needs but one single thing to prevent smoke, and that is money sufficient to make a reasonable installation in the first place. The heating and other metallurgical furnaces which are, of course, of importance in this community, are of growing importance in other cities also. In some cities like Chicago, Cleveland and Pittsburgh the steamboats contribute no small amount to the smoke, and generally in a part of the city where it is not particularly desirable.

The locomotive was for many years the black sheep of the fuel expert and the smoke expert. The locomotive has a bad name that it does not deserve as a consumer of fuel and a producer of smoke. Our electrical engineering friends are particularly severe on its great wastefulness. As a matter of fact the average locomotive of today as an economical machine is ahead of the average power plant. And the maximum and good results we have obtained are actually astonishing to many. In the testing plant at Altoona a locomotive has been operated at high power, burning say six or seven thousands pounds of coal an

hour, and giving an indicator horse power for 2.1 lbs. of coal, the locomotive being equipped with superheater.

In the effort to abate smoke from locomotives, the usual practice has been to apply air jets. The majority of the air jets, in fact, practically all of them, have been pretty crude devices, generally applied with no other engineering than the rule of thumb. In an endeavor to provide an air jet which had at least some scientific backing, the General Managers' Smoke Committee of the City of Chicago carried out some very extensive experiments in the testing plant at Altoona, taking a shifting locomotive of the type generally used in and about Chicago and other cities, and equipping it with air tubes of various shapes and in various locations, and it was found that there was one location which was better than others. Several locomotives have been fitted for such operation, two in Pittsburgh and two in Chicago. All of the roads who are members of this smoke committee are fitting up a locomotive of their own particular type so as to get information as to the desirability of using this apparatus. It is promising, at least for locomotives of certain types, those with narrow fire boxes, it will probably at least serve until some better scheme has been devised, and it will have the advantage of being correct without our going to the extent of analyzing the gases to see how much CO^2 is produced.

Mr. Searle has so adequately described the requisites of the locomotive stoker from his own view point, which happens to so thoroughly coincide with mine, that I don't know that I ought to say very much about it. I will only say that we have a number of underfeed stokers which have been in service now for several years; in fact, we have record of 21,000 trips of these locomotive stokers. On many of these trips the stoker failed; on a good many it did not. About 75% of the trips, 100% of the coal has been handled by the stoker, and the remainder of the trips have run all the way from 99% to nothing.

On one group of locomotives, which made up to the first of November of this year 8,561 trips, there were 639 trips on which but 70% or less coal was handled by the stoker; in other words, the stoker was out of service or partially out of service. As Mr. Searle states, the stoker has required a great deal of patience in its development. We now regard it as a practical machine, no longer in the experimental state, but by no means perfect.

One of the most difficult problems which I have met in the design of the stoker is to let well enough alone and see what it will do if we give it a chance. We are getting along to that stage now by having a number of locomotives equipped. Some data that I have obtained indicates that the average amount of coal used in fast passenger service, in fact, all passenger service other than suburban, and in practically all freight service other than local freight service, is about 3,500 pounds of coal per hour, fired by hand. With the stoker burning as high as 6,000 pounds of coal per hour, we have succeeded in making a trip over the road where at no time was smoke made to reach No. 2 on the Ringlemann scale, and on the entire trip the average was less than one-half of No. 1 of the Ringlemann scale. Burning the ordinary amount of coal, 3,500 pounds, the same amount as supplied by hand, we have run trips over the road where the smoke has average about .2 of No. 1 of the Ringlemann scale. Therefore, as a preventer of smoke on the locomotive, the stoker is exceedingly promising.

We have had two or three problems that we have up to the present been unable to solve. We have not lost hope. One of them is to burn satisfactorily with the stoker low volatile coal, and the other is to dispose of the products of combustion of the amount of coal that we are burning. On one of our divisions we are now rating the locomotives to where they must burn considerably more coal than is supplied by hand. On a recent trip we burned 7,800 lbs. of coal continuously for six hours, and on another trip we burned 8,200 lbs. of coal an hour for four hours. And we did not waste that coal. The train behind the locomotive was somewhere in the neighborhood of 30% in excess of the usual train hauled. These were test trains. Burning that amount of coal naturally produces a problem of disposing of the products of combustion.

With the experience of the number of trips I have referred to, we feel justified in continuing our experiments and will have more applied; in fact, there are quite a number under construction at the present time. Probably the most annoying problem that all of the railroads have is the question of smoke production in the engine house. The Pennsylvania Lines have in this city an engine house on the North Side which is located in a residential district. We have one at Chicago which is located on the

boulevard; have one at Cleveland, and are building one at Indianapolis, and all of these houses are contiguous to a more or less residential portion of the city. We have studied the problem from several view points and have made some experiments. The only important experiment, perhaps, was the installation of a very large fan and a method of washing the smoke, which was made several years ago. Unfortunately, this experiment gave absolutely no promise. At Coblenz, in Germany, I saw an engine house provided with one very large stack and all the smoke jacks led to it. There was no smoke coming from the stack. They had in the house about five of their heavy locomotives, about the size of some of our six-wheel switchers. I do not think we can draw any conclusion from the German practice, or that of any place I had opportunity to observe abroad, as to what we can do in this country where we attempt to hurry the fire. We have thought of using a large stack on our engine houses.

I have recently been watching with interest some experiments made with a peculiar type of smoke washer which is extensively used in the West in connection with melting furnaces, where valuable minerals are smelted, silver, gold and minerals of that kind, where they use a triple stack, one stack inside of the other, arranged with a water spray. It is not the smoke that they are worrying about, but the amount of metal which can be recovered from the process. This is being applied to stationary boilers in the East, and I am watching the trial with a great deal of interest. It at least looks promising. The only way I know to help the situation around the engine house is not to be so industrious in putting coal in. From personal observation, in some of our engine houses they are putting in about twice as much coal in starting the fires as is necessary, and that is neither good from our own view point or that of Mr. Searle. This practice should not be permitted.

PRESIDENT: I will call upon Mr. L. H. Turner, Superintendent of Motive Power of the P. & L. E. R. R., to add some discussion.

MR. L. H. TURNER: I cannot add a word of any value to what has been said here tonight. I have, however, a confession to make. I have found that Mr. Searle is much better informed on the smoke situation than I supposed he was. He is

the only Smoke Inspector of the City of Pittsburgh that has ever given me any trouble, but I do not believe there is a man connected with railway operation in the City of Pittsburgh who is any more willing and anxious to render him all the aid possible in the suppression of the smoke nuisance than I am. I not only ask but most urgently request Mr. Searle to meet me at some convenient time and explain to me more fully how to get this air on top of the fuel and still keep the tubes in the boiler. I know that we can, with efficient firing, control almost wholly the emission of smoke. We do not claim to go over the entire length of the road, but we can get through the city limits.

PRESIDENT: I will ask Mr. J. R. Alexander, General Road Foreman of Engines, Altoona, to say something.

MR. J. R. ALEXANDER: Mr. President, this is just a little unkind to ask a Pennsylvania Railroad man to speak after our friend Mr. Crawford has covered every avenue along the lines in which a locomotive can be operated. However, I was much interested in the paper of the evening. There is one thing which I wish to know, that is, whether my impression is correct or not that nothing can be done in stationary practice by means of mechanical devices by which the ordinary hand-fired boiler can be improved from a smoke standpoint, other than the results to be obtained from careful hand firing on the part of the fireman.

Another part of the paper that appealed to me is that a certain portion of the air for support of combustion must be put over the top of the fire. I also have thought so until recently. A few months ago I had the pleasure of going with a party to one of our small towns where they burn bituminous coal in a stationary plant to take care of electric lighting of the city and the street car system, all of which required a considerable consumption of coal. Two or three times a day they had a high peak in the current consumption that could not be met within the limits of the steam generating capacity of the boiler. In order to improve conditions they wanted to put in additional boilers, but found they could not get the material in time and they went to another experiment, which was to seal up the ash pan and install an ordinary rotary fan operated by a small steam motor in the side of the ash pan, thereby keeping a few ounces of air pressure under the grates and up through the fire. That

did two things—it cleared up the emission of smoke from that stack to about what I understood the speaker to say was the haze that indicated the best conditions in the fire box, and second, the steaming qualities were so much improved that they are not now figuring on any more boiler capacity. They are taking care of these high peaks by simply getting a better combustion in the furnace. In this case there was no air circulation above the fire, except what came through the door, and it was never open except when putting in fresh fuel. Should not something of this kind be a suggestion to our mechanical engineers as a possible scheme to improve combustion in the locomotive fire-box.

There is, I think, a very successful method in common use for overcoming dense black smoke from the stack of a locomotive. A good fireman with each fire places the door against the latch and where the employer is wise enough to furnish a uniform grade of coal, not the best, but uniform, I honestly believe where these conditions can or will be followed we will have no complaint of excessive black smoke. In regard to the stoker proposition, we earnestly hope that the underfeed stoker will overcome the difficulties now experienced, because with what experience we have had it looks to be the only stoker for locomotive purposes that will, in our opinion, meet the rigid requirements of certain city ordinances. The overfeed stoker with which I have had some little experience gives very satisfactory results, but is not as effective from a smoke point of view as the good fireman, while the underfeed stoker, as I see it, is entirely successful from a smoke standpoint, if the other troubles can be remedied.

MR. SEARLE: When I spoke particularly about air over the fire I referred to the locomotive boiler. The boiler on the locomotive today is being pushed so hard that you have to carry a rather heavy fire as compared with most stationary practice. Where you, in your best locomotive practice, burn 100 or 150 pounds of coal per square foot of grate surface per hour, we, in stationary practice, think we are doing mighty good work when we burn 30 to 35. When you burn 100 to 150 you have a terrific draft. You then create, as I have seen on charts in your railway offices, anywhere from five to seven inches of induced draft over the fire. In the Frick Building, with 385 feet of stack

seven feet in diameter, we never get over $1\frac{1}{4}''$ of draft over the fire, and the tallest steel stack in the world and a perfect breeching arrangement is in the Frick Building. Now when you are putting your draft under the fire with your fan, as you speak of, you are working on the principle of the underfeed stoker. You, of course, are burning more coal in that boiler than you would with your natural draft alone. You are also creating ashes on your grate more rapidly than with your natural draft alone, therefore the time comes very soon, comparatively speaking, when the fireman has to get his bar into that furnace, because he is not getting the results he ought to get and would get if he could catch those hydro-carbons as they are flowing away from over the fire and burn them, thus producing additional heat energy for the absorbing surfaces. After these hydro-carbon gases are cooled down by the absorbing surfaces below the temperature of combustion, there is no further opportunity to burn them. The progressive firing method that is used with the chain-grate type and the Murphy type of stoker goes along so evenly that the grate is always practically clear, because your coal passes over the length of that grate in an hour, or forty minutes, or thirty minutes, depending on how fast you are driving the boiler, and you never have so much ash forming on the grate in a given time as you would with a sharper artificial draft. When you get to the place where clinker has formed to some extent, your fire has burned down to something near the point of a wedge. It is true that chain-grate firemen will sometimes run the fire six or eight inches deep at the bridge wall, but when so heavy a fire is carried the chain-grate is a bad smoker, which, of course, stands for reduced efficiency. We have at Dilworth & Porter's four large stacks with chain-grate stokers under them. They are about as bad smokers as there are in the city, simply because they are being rushed far over their rated capacity. If the builders had known that the Dilworth-Porter Co. were going to put that load on those boilers they would have moved those grates back and would have increased their length.

As to the suggestion of Mr. Turner about keeping the tubes in repair with cold air over the fire, my explanation is that just enough air must be admitted over the fire to keep a slight haze at the top of the stack; not enough to make the stack clear, because then you may have too much air and thus reduce your furnace efficiency.

There is a gentleman in the room to-night who can tell you about large volumes of air over the fire in the locomotive firebox. I presume he is satisfied with the way the tubes are holding out in locomotives equipped for introducing large volumes of air over the fire. Mr. D. F. Crawford can tell much more about that than I can, as he has several such equipments in service on his various divisions.

MR. CRAWFORD: I do not wish to guarantee the tubes. The device has been in service only one or two months, and that is not long enough to draw conclusions. But I do not think we shall have serious trouble with the tubes as long as we maintain a brick arch. I am inclined to think that we would have trouble maintaining flues if we did not have a brick arch. We expect to try both ways, and I will be glad to give any one interested the data accumulated.

PRESIDENT: May we hear from Mr. D. J. Redding, Assistant Superintendent, M. P., P. & L. E. R. R.?

D. J. REDDING: I do not know that I can add anything to what has been said, as the situation seems to have been pretty well covered. We know that locomotives on the P. & L. E. can be fired so that they can go through that portion of the city through which we pass without violating the Anti-Smoke Ordinance. This requires careful inspection to know that the boilers are making steam freely and good work on the part of the engineer and fireman, who are required to see that a good bright fire is built up before they reach the city limits, and then to work through the city, putting in not more than one shovelful at a time. By doing this, we go through the city limits practically without making smoke.

MR. SEARLE: I would like to say one thing along that line. I have spent some thirty years now in steam engineering, and I am bound to say that I am gratified and surprised at the way Mr. Turner gets his locomotives over seven miles of track in Pittsburgh practically without smoke. I have had men stationed at Sheridan, at the Point, across back of Birmingham depot, and out toward Becks Run, and to my certain knowledge these engines will come up to Saw Mill Run with a stack issuing as black smoke as you ever saw, and in ten seconds that stack will be clear. And we do not see any more smoke while passing through Pittsburgh, except an occasional puff which indicates

that somebody has put one shovelful of coal on that fire. Mr. Turner tells me how he does it. He says he instructs the engine crew to come to Saw Mill Run with the fire sufficiently good to go through that seven mile city limit firing one shovelful of coal at a time and no more. And he tells me that if I or my men catch any of his men disobeying that order he will see that they do not do it again. I do not know whether he has had any occasions to censure his men or not, but I do know that his locomotives are coming up that seven mile grade with wonderfully clear stacks.

Now about this question of air over the fire. That is a matter to be experimented with. There are no two cases that will work out just exactly alike. In Mr. Crawford's practice I know that he is very much encouraged, so much so that I hear every two or three days as to the good work those air-equipped locomotives are doing. If locomotives so equipped will do the work, I shall be glad, because the device he is working out is very expensive to install.

MR. ALEXANDER: May I say a word further on the subject of smoke in the city. The railroad with which I am connected runs through cities having restrictions about as strong as they can be. In getting the required results the railroad is many times treated very unfairly, as for illustration, locomotives may be coming along with a train working 30 or 40 per cent cut off with the best of fire and the water level at the proper height and the stack passing out more or less smoke. When these engines come within the prohibited district they must not make any smoke, because if they do there is a penalty attached. The way to be safe is to open the door more or less wide, and if the engine is not working hard enough to dissipate all the smoke, on must go the blower. If there is any one thing in the world that will tear flues out of the engine, this is the treatment that will do it, and too often is this means taken to secure the desired results. Whenever you hear an engineer blowing about not getting any smoke he is doing it in that manner. No doubt if the railroad can stand it the engineer can. It is but fair to refer to such practices in a meeting of this kind, for the reason that it may lead railroad people and the smoke inspectors to design some means by which methods of that character will not have to be resorted to. In my judgment the P. & L. E. R. R. have

as good men as the Pennsylvania, and if they are told to do a thing they do it, and that is the only way I know to entirely overcome black smoke in the residential district.

MR. SEARLE: The Pennsylvania Railroad Company have the hardest smoke-abatement proposition in the City of Pittsburgh. Their locomotives must roll down from the Twenty-eighth Street Round House and start out of Union Station with a heavy train and get to Brushton, every foot of the way up a heavy grade, without making disagreeable smoke, and this is something to keep the engine crew studying. And I want to say to you that engines leaving the Union Station and landing at Brushton are going out with about 40% of the smoke today that they did before Mr. D. M. Perine and Mr. J. M. James, Superintendent Motive Power, commenced work on the proposition of cutting that smoke down. I have asked Mr. Perine and Mr. James (and I know they are doing what I have asked them to do) if when their engineers come to a block and have to shut off, and the door is not already unlatched, if they would not drop the door on the latch and put the blower on just enough to keep the product of that green fire in flame and not let it go into the tubes and out the stack as smoke, and they have issued such an order. Before they did that (and this is where I get some of my best proof), letters were coming into my office anywhere from five to twenty a day, saying: "We can't stand this smoke. The Pennsylvania Railroad locomotives are destroying our homes." I am not getting anywhere near as many of those complaints now, and when I see those gentlemen whose homes were being destroyed they say the change for the better is quite remarkable. Now and here I wish to give all the good news I get to the railroad officials who have the smoke of their locomotives to abate, because they have been mighty kind to me as Chief Smoke Inspector of this city.

At Mr. Crawford's invitation I have ridden on his locomotives that are equipped with underfeed stokers, and I know what that stoker will do as a smoke abator and am more than pleased that his Company are putting on several of those stokers and are going to equip all of their locomotives with them. When the locomotives on the Lines West coming into Pittsburgh are all equipped with these stokers we will not have any smoke from the locomotives of the Lines West. I have already spoken of the

satisfactory work Mr. Turner is doing coming through those seven miles of our city. These are conditions that I see every day of my life.

MR. TURNER: When Mr. Alexander speaks on the subject of locomotive operation, he is talking on a subject on which he is fully informed, so much so that he knows it is simply impossible for locomotives with a train load ranging from 4500 to 5000 tons, and with a tractive power of 45,100# to be run with a wide open door and hold onto their steam, fire, or tubes.

Our manner of handling the work is to approach the city limits with a good substantial fire in the box, then put in a shovelful of coal here and there where the fire is getting thin and burning brightest. The amount of smoke thrown from such a small portion of coal is but little, and most of it is consumed before it reaches the atmosphere, but it requires good work on the part of both the engineer and the fireman in order to do this in a manner acceptable to the city authorities.

MR. ALEXANDER: I just want to get straight about that open fire door. Possibly I did not make my remarks strong enough to be understood. There are not many places where engines use 30 or 40 per cent. cut off through large cities, but whether working hard or moderately, say if conditions were as stated where an engine was seen approacring the restricted district making all kinds of black smoke, and if I recall correctly the words used, the observer said the black smoke stopped in a twinkling of an eye. If that is the way the smoke disappeared from the top of the stack, I know of no way other than the wide open door, possibly the shutting off of injectors, etc., that can so quickly dissipate black smoke, as with a hot fire having plenty of coal, there is no time to get rid of the smoke any other way. The more or less wide open door and strong use of blower is also frequently necessary in passenger service when shutting off steam running into and out of stations. Another thing railroad men should keep in mind, is, that the people outside of city limits also have some rights or protection from the smoke nuisance. In other words, should any scheme or device be approved or considered satisfactory that cannot be operated so as to give the same results at all points on the line as far as smoke is concerned.

MR. TURNER: Please understand that we do not attempt

to go over the entire road firing an engine in this manner. We simply try to get through the city limits, and we have to make a little sacrifice of water and possibly of steam. In our passenger service we have to depend largely on the fire in the box when leaving the station to take us outside the city limits, but we have to have a good fire in starting or else we could not haul twelve cars sixty-five miles in an hour and thirty minutes and make five stops, but with two men on the engine who know their business and work with each other, wonders can be accomplished in the suppression of smoke.

PRESIDENT: The University of Pittsburgh has been making some researches into the question of smoke prevention, and we have with us Prof. Bacon, of the University, and I will call upon him.

PROF. R. F. BACON: I will say only a few words in regard to our investigations because they cover a very wide field and I think the subject has been well covered in what has been already given.

But there are one or two things. I was glad to hear Mr. Searle emphasize the efficiency factor in the smoke business, because all around Pittsburgh the cry is "Smoke means prosperity." I have been surprised at the marked prejudice in that respect. I think you will realize from Mr. Searle's excellent paper that smoke means ignorance and inefficiency.

We have a number of experts along different lines studying smoke from different standpoints. In the first place, from the economic side, we have collected exact data as far as we can on the cost of cleaning buildings, both in this city and other cities, the cost of individual laundry, and the cost of all kinds of cleaning operations, the effect of the smoke on the need of repainting, and things of that kind, and the figures Mr. Searle gave you as the actual economic loss in the Pittsburgh district now he gave at about three or four millions. The actual figures, from data we have, will be more than ten million dollars per year.

One other question. We early recognized that there were certain kinds of furnaces and certain buildings where it is almost impossible to burn coal in a smokeless manner, certain metallurgical furnaces where you must have a reducing atmosphere, and that had to be overcome, too. So we decided that

with certain types of smoke producers we could not burn the smoke up as we do in ordinary practice, but must precipitate the smoke in some way. We have worked a great deal along that line, particularly the precipitation with high tension electric discharge, and we have been very successful. At the present time we have only an arrangement that will take about a three-foot stack. But this high tension electric discharge cuts off the smoke absolutely; it is all precipitated. And we have reason to believe from work that has been done by Cottrell on the Pacific Coast that this thing can be put into practical operation so that in round-house smoke and certain types of metallurgical furnaces where you can not get rid of smoke by combustion, that is, by burning the coal in such way as to avoid making smoke, we have the apparatus to abolish it.

MR. SEARLE: In referring to an annual waste of three or four million dollars in this city, caused by unnecessary smoke, I wish to make myself clear. I only referred to two propositions. One was shelf-worn and counter-handled goods, and the other was increased laundry and garment-cleaning bills. Of the two gentlemen of whom I spoke, one suggested that the loss was from 10% to 20%; the other said it was 20% flat. But realizing perfectly well before I got half way through with my paper that if I undertook to handle the problem in great detail I would have a paper that would go all night, I was compelled to close. I am glad Mr. Bacon brought that ten million dollar estimate up. It is practically all right when you take all the elements of waste from unnecessary smoke into consideration.

PRESIDENT: The question is now open for general discussion. If there is nothing further, do you wish to say anything in closing, Mr. Searle?

MR. SEARLE: The principal thing is to express my satisfaction at the subject having induced so much earnest, intelligent, and practical discussion. Such discussion as has been participated in by the members of your Club on the floor tonight is very helpful to the cause of smoke abatement. The idea of the paper was to say something that would in some way start an intelligent and scientific discussion by the members of this Club, whom I knew were perfectly capable of discussing this question. I am more than glad I came here, first, to see and become better acquainted with you, and next, to listen to your able discussion of

this question. And I thank you very kindly for your courtesy in inviting me to read a paper to you on the abatement of smoke.

MR. TURNER: I want to repeat what Mr. Crawford has already said and to thank Mr. Searle personally and also congratulate the Club on having so able a paper presented. I move that the Club extend a vote of thanks to Mr. Searle for the very interesting subject presented to us to-night.

The motion was duly seconded by Mr. Crawford and carried by unanimous vote.

PRESIDENT: Mr. Searle, you have the thanks of the Club.

MR. SEARLE: I thank you.

ON MOTION, Adjourned.

J. B. Anderson
Secretary.

OFFICIAL PROCEEDINGS
RAILWAY CLUB OF PITTSBURGH
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Vol. XII. DECEMBER 19, 1912 No. 2.

HEAT TREATMENT OF CHROME VANADIUM STEEL
BY MR. A. F. MITCHELL, SUP'T TREATING SHOP, CARNEGIE STEEL CO., MUNHALL, PA.

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OFFICIAL PROCEEDINGS

OF

The Railway Club of Pittsburgh

Organized October 18, 1901.

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Vol. XII. No. 2 **Pittsburgh, Pa., December 19, 1912.** $1.00 Per Year 20c Per Copy

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, DECEMBER 19th, 1912.

The regular monthly meeting was called to order by the President, Mr. A. G. Mitchell, at the Monongahela House at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Adams, Lewis
Anderson, D. W.
Anderson, J. B.
Amsbary, D. H.
Antes, E. L.
Ashcroft, C. D.
Ashworth, Wm.
Bailey, R. E. L.
Baldwin, G. C.
Bannister, E. J.
Barth, John W.
Battinhouse, J.
Bennett, R. G.
Buechner, W. A.
Burns, J. D.
Byron, A. W.
Cullen, J. C.
Clark, H. L.
Crouch, A. W.
Coulter, A. F.
Courtney, D. C.
Dravo, M. S.
Drayer, U. S.
Fitzgerald, H. M.
Forsythe, Geo. B.
Geddes, Jas. R.
Gilbert, A. D.
Goetz, H. L.
Hair, H. J.
Harner, A. J.
Harriman, H. A.
Herlehy, Thos. W.
Herrold, A. E.
Hilty, H. A.
Hoffman, C. T.
Howe, H.
Kelly, H. B.
Kinch, L. E.
Kinter, D. H.
King, Wm. R.
Knox, Wm. J.
Kopfershmidt, B.
Lobez, P. L.
Lynn, Samuel
Mackert, A. A.
Mensch, E. M.
Mitchell, A. F.
Mitchell, A. G.
Murphy, V. J.
McNulty, F. M.
Newman, L. L.
Noble, D. C.
Orner, M. T. S.
Parry, Wm. I.
Pechstein, A. J. G.
Porter, H. V.
Raser, Geo. B.
Redding, D. J.
Reymer, C. H.
Robbins, F. S.
Rupp, R. D.
Ryan, Wm. F.
Sampson, J. M.
Schauer, A. J.
Schomberg, W. T.
Schoming, Geo.
Shuck, Wm. C.
Schultz, Geo. H.
Shallenberger, C. M.
Sharpley, H. G.
Sinclair, Angus
Shook, A. A.
Shremp, J. A.
Stucki, A.
Smith, Russel
Smith, Wm.

Snyder, Jos.
Sullivan, W. H.
Tucker, John L.
Warne, J. C.
White, F. L.
White, J. D.
Williams, R. F.
Williams, W. W.
Wood, Ralph C.
Wyke, J. W.

VISITORS.

Allen, F. G.
Barnes, H. C.
Barnes, John
Beebe, I. L.
Blake, F. H.
Boring, P. J.
Bowes, Geo. S.
Brophy, John J.
Cain, C. C.
Cruttwell, J. C.
DeWalt, W. T.
Doane, W. S.
Dunlap, A. N.
Felker, A. W.
Foltz, T. F.
Gantt, E. T.
Gray, Arthur
Gray, Wm.
Grayble, W. H.
Kernohase, B. W.
Kinch, D. L.
Knauer, H. S.
Krasan, H. T.
Leech, C. C.
MacQuown, H. C.
Macy, F. W.
Markland, W. H.
Millholland, W. K.
Meyer, J. G.
Miser, R. R.
McGee, W. J.
Noble, H. N.
Parrish, J.
Pechstein, T. M.
Peterson, Gustaf
Pratt, Ira D.
Roberts, Wm.
Schenck, R. B.
Schofield, J. S.
Shults, I. Jay
Sinclair, C. F.
Stoop, W. J.
Trimmer, J. W.
VanHofer, R. M.
Warren, C.
Weibley, R. H.
Winterhalter, A. M.

PRESIDENT: The minutes of the last meeting being ready for publication, we will omit the reading of the same.

The Secretary read the following list of applicants for membership:

Doane, Willis S., District Sales Manager, Davis Bournonville Co., 2930 Penn Ave., Pittsburgh. Recommended by B. Kopfershmidt.

Dzugan, John, Signalman, Union R. R., Port Perry, Pa. Recommended by R. S. Wilson.

Floyd, W. J. C., Dept. of Supplies, City of Pittsburgh, 815 St. James St., Pittsburgh. Recommended by John W. Barth.

Lester, C. E., Asst. Master Mechanic, B. & O. R. R., Glenwood, Pa. Recommended by L. Finegan.

Mullin, D. C., Asst. Storekeeper, P. R. R. Co., 529 Finley St., Pittsburgh, Pa. Recommended by Chas. McGaughey.

McIntyre, G. L., Traveling Engineer, Pittsburgh Brake Shoe Co., Pittsburgh, Pa. Recommended by U. G. Detwiler.

Ryman, Frank, President, Etna Forge Bolt Co., House Bldg., Pittsburgh, Pa. Recommended by E. J. Bannister.

Salkeld, Roy C., Asst. Chief Draftsman, Pressed Steel Car Co., 148 Davis Ave., Bellevue, Pa. Recommended by Harry Howe.

Shade, Howard M., Air Brake Instructor, P. R. R., Conemaugh, Pa. Recommended by S. G. Glassburn.

Shults, I. Jay, Dist. Manager, Hoskins Manfg. Co., 1404 Oliver Bldg., Pittsburgh, Pa. Recommended by W. A. Buechner.

Smith, John L., Master Mechanic, P. S. & N. R. R., St. Marys, Pa. Recommended by C. E. Stillwagon.

Stromer, Wm. M., Telegrapher, P. R. R., 381 Second St., Pitcairn, Pa. Recommended by S. R. B. Stewart.

Towson, T. W., Piece-work Inspector, P. R. R., Verona, Pa. Recommended by U. G. Detwiler.

Ward, R. H., Storekeeper, Union R. R., 7614 Kelly St., Pittsburgh, Pa. Recommended by R. S. Wilson.

PRESIDENT: As soon as these names have been favorably passed upon by the Executive Committee the gentlemen will become members.

SECRETARY: It is with regret that we announce the death of Mr. C. L. Hinsdale, General Foreman, P. & L. E. R. R., who died December 10, 1912. He was elected to membership in this Club November 24, 1905.

PRESIDENT: Next in order ordinarily would be the reading of the paper of the evening. But before taking up this subject I wish to ask if we can have a few words from our fellow-member, that Grand Old Railroad Man of New York, the President and Editor of the Railway and Locomotive Engineering Journal, whom we have all known by reputation, if not personally, and whom it has been my great pleasure to have known for many years. I now have the pleasure of introducing to you, Mr. Angus Sinclair.

MR. ANGUS SINCLAIR: Mr. President and Fellow-Members of The Railway Club of Pittsburgh:—I am very much pleased to be with you here tonight and to see so many signs of activity in the Club and particularly the number of new members who have applied for admission into the Club. I am naturally one of the old Club members and consequently I have had a great deal of experience with railway clubs. From what I have seen and learned of them I think they are doing a wonderfully good work for those who have become members.

We hear a great deal nowadays about educational work. Education is the word repeated in every department of industry, and strenuous efforts are going on to improve the education of all classes. But in regard to railroad men, train men, and shop men in particular, I think the railway clubs have been as good an educational force as anything that I know of or anything that has reached railroad men.

When I joined the American Railway Master Mechanics' Association, a great many years ago, when there were not more than one or two railway clubs in the country, it was very difficult to get members to get up on the floor and express themselves, even in regard to subjects they were very familiar with. They had not been accustomed to expressing themselves while on their feet and they became so nervous after standing up that they could not tell the things that they were well able to speak about and that would be of benefit to the meeting to hear. Nowadays, I notice in the larger associations, the associations that meet merely once a year, such as the Master Mechanics, the Master Car Builders, the Traveling Engineers, Shop Foremen or Air Brakemen, whatever subject comes up there is always a host of men ready to take part in the proceedings and to give valuable information on the subject under consideration.

Now, I attribute that to the work of the railway clubs. Take men who can hardly put half a dozen words together when they first stand up to talk, and very soon they begin to gather more confidence and are not so nervous, and by degrees they become fair speakers, some of them even eloquent. I had an edifying experience with one particularly bright Superintendent of Motive Power. At the meetings he was silent, like a good many others, but he could discuss matters readily enough outside, but not a word out of him at the meetings. I was Secretary of the Mas-

ter Mechanics' Association at that time, and I said to him, "Now you have got to say something, even if it is only to move to adjourn. If you don't get up and say five words I will draw attention to you and say you ought to say something on the subject." Well, he started in at the convention and spoke a few words, and a few years afterward he was elected President of the Association and he became one of the readiest speakers who attended those meetings. That is the education that you practical men get in the railway clubs. A man who leaves school without learning to speak in public and goes to work, finds expressing himself on the floor to be very difficult and he needs bracing up to acquire the art of speaking. The art of speaking is the art of giving information. So I think it is a good thing all the way along that the art of speaking, the art of giving information, should be encouraged. And there is nothing in my opinion that encourages and develops the art of giving information so well as the railway clubs.

Gentlemen, I am very glad to be with you, and am flattered with the notice which your president has given me, and I hope that I may be able to meet he and you many times before my life is run out.

PRESIDENT: Gentlemen, I hope you all heard the suggestion that was made by Mr. Sinclair. And I hope you will take it to heart, and if called upon to speak, or even if you are not called on, you will let us hear your voice.

The subject of the paper as given in the notice for this evening was somewhat in error. The subject should have read, "Heat Treatment of Chrome Vanadium Steel." This subject will now be presented by Mr. A. F. Mitchell, Superintendent Treating Shop, Carnegie Steel Company.

MR. A. F. MITCHELL:

HEAT TREATMENT OF CHROME VANADIUM STEEL.

BY MR. A. F. MITCHELL, SUPT. TREATING SHOP, CARNEGIE STEEL COMPANY, MUNHALL, PA.

Mr. President and Gentlemen:—I consider it an honor that you have conferred on me to present, for your consideration, this paper on the heat treatment of chrome vanadium steel. You will

find that this paper takes the form somewhat of general remarks on this part of the steel industry, as it is proposed to deal with the simplest terms, and it would be impossible to deal at length with many details on so broad a subject in one evening.

The many places where heat treated alloyed steels are superseding the plain carbon steels are clear indications of hundreds of other places to apply the former. The wide field for experimenting; for example: different temperatures, mediums and methods of quenching; also tempering or drawing back of these steels, for the various purposes intended; seems to be unlimited.

The construction of automobiles has, to a greater degree than any other industry, forced the steel maker to furnish a better product. It has also done more than any other industry to compel steel makers to compete with each other in increasing the quality of their products, by the addition of alloys, and the use of various heat treatments; the results being marvelous, when the strength and endurance of the vital steel parts of the best makes of today are compared with those constructed a few years ago.

Like many other well known modern improvements which are being applied in diverse places at the present time, it is obvious that heat treated alloyed steels can also be used to advantage where constructing engineers are endeavoring to increase the strength and endurance of machines or parts of the same.

There are exceptional places where heat treated alloyed steels may never be more efficient than plain carbon steels. And there are other places where, as yet, it has been impossible to replace plain carbon steel by heat treated alloyed steels on account of lack of knowldge as to proper composition and heat treatment, which only comes by experimenting or in "cut and try" methods which are sometimes long, tedious and costly.

In presenting this paper stress is particularly laid on the heat treatment of alloyed steels, as they are coming into prominence more and more every day. What interests us most is how to overcome the difficulties and improve the conditions of today and tomorrow.

About the first query generally put to one is, "What is heat

treatment?" The term "Heat Treatment" comprises the operations of heating and cooling steel to produce the properties which are desired. The term is of comparatively recent origin, although the processes, such as annealing, hardening and tempering have been praticed for centuries. Modern heat treatment of steel began about twenty-five years ago, or about the same time that means of measuring heat accurately, by the use of pyrometers, and also when microscopic examination of the changes in the structure of steel began. The ability to determine, accurately, temperatures in the different heating operations, and the different methods employed, in determining the changes produced, are the basis of modern heat treating methods. The application of heat to steel will increase its temperature up to a given point called the point of calescence or transformation. At this time further application of heat will not increase the temperature, but is taken up in the molecular change or reconstruction, which takes a varied amount of time, according to its chemical composition or percentage of elements present; following this, the temperature again increases. At, or above, this point of rearrangement the steel has the quality of becoming hard if quenched. If cooled without quenching the reverse takes place; the reduction in heat being regular to a certain temperature; then it stops for an interval, after which it cools regularly, losing its hardening power. Low carbon steel and some of the alloy steels have two or three points of reconstruction or critical points, but high carbon steels and those of medium carbon content usually have one point. Various elements, such as nickel, chromium, tungsten and vanadium, raise or lower the temperature of the critical point.

As different quantities of carbon and other elements present determine the qualities possible to obtain by heat treatments, it is not a logical proposition to use the same composition of steel or the same heat treatment, or to have the same physical properties for the purposes intended. The qualities of a crank shaft, which may make 1,000 to 1,200 revolutions a minute and has torsional strains and journal wear, as compared with a I beam, where principally the work is static or largely devoted to holding the weight of the structure, should differ according to the requirements. As stated before, to be able to properly heat treat steel, it is necessary to first procure a steel of known chemical

composition, which has been proven, by practice or experiment, that it can be so heat treated as to get it into the best possible condition for the purpose intended.

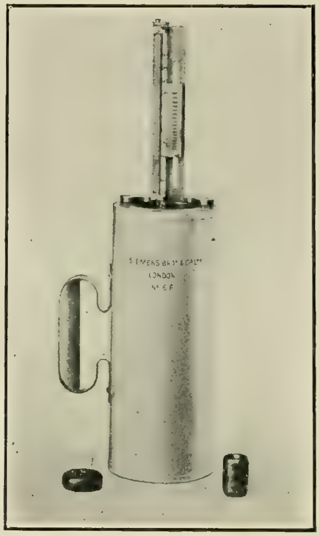
Spring Steel:—

If a steel containing the elements chromium and vanadium is used for making springs, where high elastic limit and great toughness are required, it should contain .54 to .61 carbon for Locomotive Springs, and .46 to .53 carbon for Automobile Springs: .70% to .90% manganese, .80% to 1.00% chrome, and .16% to .25% vanadium. This steel, heated to 900 degrees centigrade, quenched in oil and drawn back at 550 degrees centigrade, will show an elastic limit to from 150,000 to 175,000 pounds per square inch; a tensile strength of 185,000 to 220,000 pounds per square inch; elongation in 2 inches of about 15%, and about 40% in reduction of area. Another important quality of this steel, when properly heat treated, is its silky fibrous structure, which can be seen when the spring is bent until it is broken.

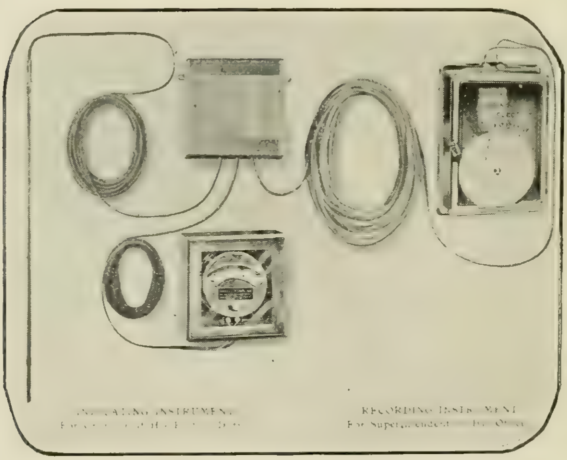
Carbon spring steel containing about 1.00% carbon and .30% manganese, when heat treated, will show about 130,000 pounds per square inch elastic limit, 170,000 pounds per square inch tensile strength, 9.5% elongation in 2 inches, and 16% reduction of area. If it is bent until broken the fracture will show a fine crystalline structure.

The heat treatment and forming of springs, as performed by many spring makers, is the same at the present time as at the beginning of the art. They have not changed their methods with changed requirements of machines, or changed compositions of steels. This will apply to many makers of other machine parts. Other manufacturers, we are pleased to say, have kept pace with the increased requirements of the times by introducing new methods necessary to improve their product. To properly heat treat spring steel and get it into its best possible condition, the process of manufacture must be so arranged that it will not interfere with the quenching or drawing back at the proper temperatures. Chrome vanadium spring steel should be heated from 850 to 900 degrees centigrade and quenched in oil. If the forming of the leaves or coils lowers the temperature below the hardening point, or cause it to be uneven, it should be reheated

before quenching. If quenched without reheating the steel will have a complex treatment consisting of an uneven air hardening and an oil annealing. According to composition and intended



No. 1—Outside view of Siemen's Water Pyrometer and two Iron Cylinders.



No. 3—Electric Pyrometer, showing fire rod, lead wires and galvanometers for shop and office.

purpose, the drawing back temperature should vary from 450 to 550 degrees centigrade in an evenly heated furnace, or, better still, a bath of molten lead.

Determination of Temperature:—

For the different heat treatments, the temperature of the steel may be accurately determined by the use of a pyrometer, many of which are upon the market today. The speaker has used the Siemen's Water Pyrometer for many years, and, while it requires more physical exertion to operate than electric pyrometers, for general shop use where the heat treating furnaces are being repeatedly raised and lowered in temperature, as well as pieces of uneven sizes being heated, the water pyrometer is the best suited to this class of work. In using this pyrometer, a small cylinder of copper, iron, nickel or platinum, of known weight, is placed in the furnace and heated to the same color as the steel, as near as the eye can detect by comparison; and should be almost invisible when held in a straight line between the eye and steel. It is then quickly transferred to the calorimeter, which contains a thermometer, a graduated sliding scale, and 568 C. C. of water. The temperature of the water in the calorimeter increases until the temperature of the water and cylinder becomes the same. During the above operation the mercury in the thermometer has been gradually rising, and, when it becomes stationary, the temperature of the steel is determined by reading the brass scale to which is added the temperature shown on thermometer. As the cylinder decreases in weight from oxidation, which in turn apparently reduces the temperature, correction is made by a table which specifies the addition of a certain number of degrees for each gram of loss of the cylinder. This pyrometer will only give correct temperature readings when all of the specified conditions are fully adhered to; this also applies to any good pyrometer and differs only in points of construction and methods of handling.

Electric pyrometers with alloy couples (thermo-couples), one junction of which is in contact with the steel in the heating furnace, is generally supposed to show the correct temperature on the dial of the galvonometer. This may be true, providing the furnace is uniformly heated to the required temperature, and the steel remains in the furnace for a predetermined length of time, sufficient to thoroughly penetrate it; then, and not until

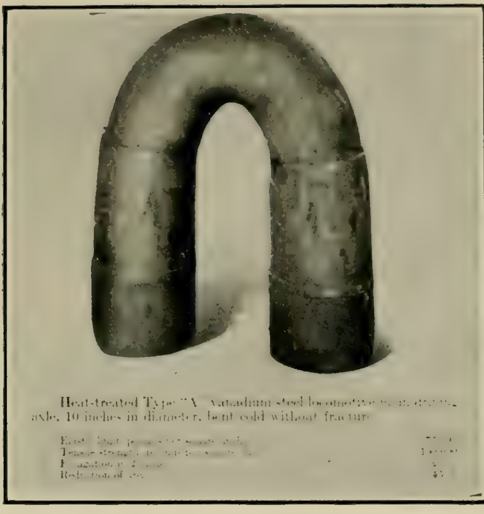
then, would the accurate temperature of the steel be recorded on the dial of the galvanometer.

As pyrometers are delicate instruments, when used in shop practice, it is advisable to have them frequently checked up with a standard or returned to the manufacturer for that purpose. It is not possible, at this time, to go into the details of construction, installation and operation of pyrometers. Before leaving this part of the subject, however, I would like to say that I am convinced, after years of experience, that the electric pyrometer is superior to the water pyrometer only when used in uniformly heated furnaces, and repeatedly used for the same class of work. Water pyrometers, using metal cylinders for the comparison of color, are superior to electric pyrometers where the furnace is constantly being raised and lowered in temperature, and where steels of various compositions and sizes are being heated. Determination of temperature, by the eye alone, can only be resorted to as a rough guide. For example, until the steel is from 50 to 100 degrees below the required temperature, or, in exceptional cases where a pyrometer is not available. The application of heat treated steels to hundreds of different uses, at the present time, coupled with the many different alloys, have limited the range of temperatures. To produce the required properties in the steel, it is necessary to acquire a certain degree of heat, and be able to repeat the same daily without serious deviation. This is impossible to do with the eye; first, because of the different diffused light in the shop; and, second, on account of the unreliability for a person to carry from day to day the different colors which represent different temperatures.

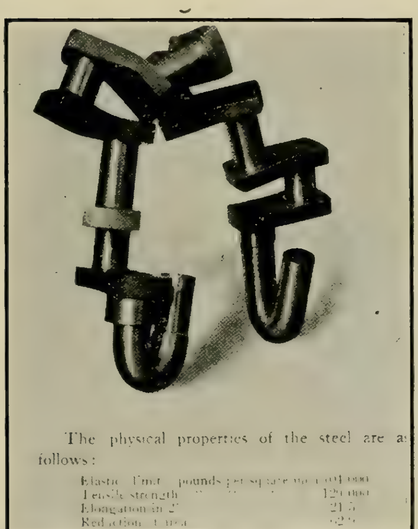
A good pyrometer will soon pay for itself many times over. Objections to change from physical to mechanical means, or from the eye to the pyrometer, to determine temperature, is found only in shops that are not progressive. It would be as reasonable to hold to the ancient means of transportation as it would be to continue endeavoring to properly determine temperature by the eye.

Forgings:—

All grades of steel alloyed with vanadium and chromium should be heated from 850 to 900 degrees centigrade for quenching. This will give the best refinement of structure preparatory to drawing back. Heat treatments for forgings vary in tem-



No. 7—(See Plate.)



No. 13—Distorted Automobile Crank Shaft.

perature and time of heating according to chemical composition, size, and physical properties required.

Chrome vanadium forgings containing .50 carbon, .75 chrome and .20 vanadium, or above, should not be allowed to go

cold before annealing. This is what we might term a mild self-hardening steel. The coarse structure produced by the high, and sometimes uneven temperatures, and the strains set up by the operation of forging, causes the steel to often crack; the rupture always occurring at the point of uneven strain. In a forging of unequal size the crack usually shows parallel to the cross-section where the heavy and lighter sections join; in a forging of equal cross-section they usually run longitudinal. The steel should be allowed to cool just below color, then heated from 800 to 825 degrees centigrade and cooled slowly in the furnace, lime or ashes. This will prevent cracking due to air hardening from the high forging heat.

Cracks may be produced in chrome vanadium steel of the above composition, or even sometimes in milder types, in the quenching bath. It is a safe rule, in the milder types, not to allow the steel to cool below 100 degrees centigrade in the smallest cross-section, when quenching in water; the higher types should be cooled to 300 to 350 degrees centigrade. Oil, being a milder quenching medium, will not produce such an extreme hardness at the surface as water, consequently it will not be necessary to exercise quite as much care in the quenching. Improper heat treatment methods may spoil good steel. On the other hand, physical defects in steel can never be eliminated by heat treatment.

The time of heating for quenching or drawing back forgings will vary according to size. Heat treatments for a few forgings, such as axles, connecting rods, cranks, shafts, crank pins and steering knuckles, for locomotives, automobiles, etc., are as follows:

ANALYSES	Heat Treatment		Elastic Limit lbs. per sq. in.	Ultimate Strength lbs. per sq. in.	Elongation in 2"	Reduction of area.
	Quench Deg. C.	Draw Back Deg. C.				
Car. .25 to .35 Mang. .35 to .55 Cr .60 to 1.00 Van. .18 to .25	850 to 900 in Water	650 to 675 in Air	80,000 to 90,000	100,000 to 125,000	20 to 25 per cent	40 to 60 per cent.

To obtain the above physical results, when quenching in oil, reduce the drawing back temperatures 100 degrees C. To increase the elastic limit and ultimate strength reduce the drawing back temperature only; each drop of 50 degrees producing

an increase of 6,000 to 10,000 pounds per square inch. The elongation will be lowered gradually from 12% to 15% in a reduction of 200 degrees C. The reduction of area will also diminish from 6% to 10% with the same reduction in temperature.

The above table has been calculated from round sections varying from one to ten inches in diameter; the quenching medium reducing the temperature fast enough to hold the carbon in its hardening condition throughout the mass. It is obvious that pieces of a less or greater diameter would necessitate drawing back at higher or lower temperatures to obtain the same physical results; the intensity of hardness varying with the rapidity of cooling in the quenching bath.

Case Hardening:—

Case hardening is a heat treating process in connection with the use of a carbonaceous material. This produces a hard layer of steel next to the surface, gradually decreasing in hardness until it blends with a soft steel of a homogenous nature. Thus it will be seen that no steel of hard carbon content throughout should be used, as it would harden clear through when heated and quenched.

The articles to be case hardened should first be thoroughly annealed in lime or ashes, then the parts to be cased should be machined to finished size. Should the annealing be omitted, permanent distortion is liable to take place during the carburizing heat. The articles are then packed in a container having the parts to be cased in contact with the carbonaceous material. The container should not be larger than required and the articles to be cased packed in such a way that the heat has a chance to reach all the contents at about the same time. Many good carburizing mixtures are to be found, some of which can be used several times by adding new material and thoroughly mixing with that which has been used. The finer the carburizing mixture is the more uniform the hardness of the case will be. The character of steel to be cased and the results desired differ so much at the present time, that no one compound is best for all conditions. Sometimes certain parts are to be left in their original condition and the remainder case-hardened. This can be accomplished by using for a protection a non-carbonaceous material that will not

fuse at the carburizing temperature. This is usually a good grade of silica sand or asbestos. Steel plates are sometimes used to advantage. The protection of parts not to be cased is accompanied by many difficulties depending on the shape of the articles and the parts to be protected. Experience will be the best teacher to successfully accomplish this part of the process.

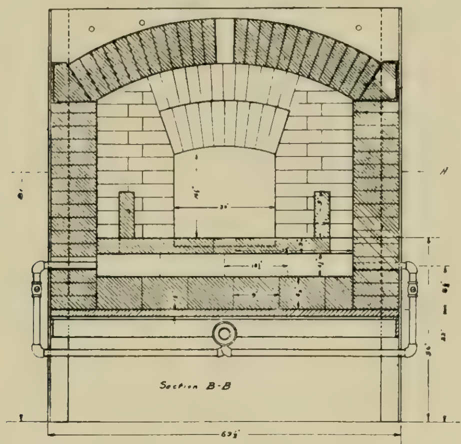
The box is then sealed, charged in the furnace and heated from 850 to 1000 degrees C.; the temperature depending on the quality of carburizing mixture used. The length of time necessary to maintain the carburizing temperature must be regulated to suit the depth of case required; the quality of carbonaceous material; composition of steel; temperature and maintenance of carburizing heat; each playing their respective parts in amount of carbon absorbed and depth of penetration. Following this the article is allowed to cool in the box, then removed and heated to 800 degrees C. for annealing. After machining the uncased parts to finished size, it is heated to 900 degrees C. in a semi-muffle furnace and quenched in oil to refine the uncased portion. It is again re-heated to 800 to 825 degrees C. and quenched in water, and, when cooled to about 100 degrees C., is thrown into an oil bath which has been previously heated to 180 to 200 degrees C. or higher, depending on the hardness desired, and left until uniformly heated to relieve strains due to quenching.

If a machine part is exposed to constant friction it will wear down, lose its original dimensions and become unfit for its specific use. To withstand the wear it must have an extremely hard surface. But a smooth and hard surface means a good deal more to it, as it can be more durably polished, offers less friction when in contact with other parts, and is less liable to rust. When the hard surface is combined with a relatively soft, elastic body, the part will be able to withstand sudden shocks without flying to pieces and will be able to yield to stresses and strains without being permanently deformed. This valuable combination of hardness and resiliency is obtained by the case-hardening process.

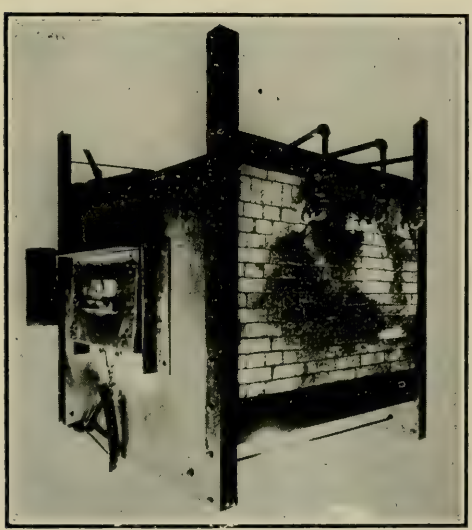
Clearly the instances where case-hardening could be used to great advantage are practically numberless, but, owing to the neglect of the most elementary rules of the operation or the un-

scientific methods of applying them; the lack of care in selecting a proper case-hardening material, the indifference with which the work is packed and heated, and the consequent uncertain or unsatisfactory results obtained, case-hardening has not attained to that broad and general application to which it is entitled.

Among other articles, or portions of the same, which are,



No. 4—Cross Section of Heating Furnace.



No. 5—Outside View of Heating Furnace.

or should be, case-hardened, may be named: gears, pinions, shafts, wrenches, roller bearings, chucks, vises, cams, hubs, etc.

Methods of Heating:—

In heating steel it is essential to know the best method to reach the desired temperature with the minimum oxidation.

The principal methods used being the electric, gas or oil furnaces, and lead or oil baths. Each may be differently constructed and of such capacity as best suited for the articles to be heated.

Oxidation is least in the electric furnace, but its usefulness is limited, on account of its size, to the smaller machine parts or tools, such as taps, dies, reamers, gears, bolts, etc. It is ideal for heating small case-hardened articles for quenching; the non-oxidizing chamber preventing decarburization at the surface.

The lead bath has also its limits of usefulness, principally due to rapid oxidation of the lead. Also its weight and liquid form making it necessary to use cast iron or cast steel pans. This means that the higher the temperature the more the sag in the pan, which, having little support, soon cracks. Crucibles are sometimes used to advantage, for high temperatures, such as used in hardening high speed tool steel. Its most important use is for drawing back or tempering springs between the temperatures of 450 and 550 degrees C.

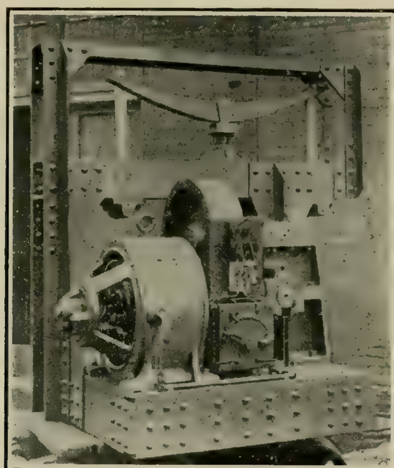
The oil bath being limited in temperature to the flash point of the oil, can be used only for tempering or drawing back between the temperatures of 200 to 300 degrees C. All case-hardened articles should be drawn back in oil, also homogeneous steel machine parts of high carbon content, such as gears, dies, die rings, gun forgings, pneumatic tools, punches, rivet sets, etc.

The gas and oil fired furnaces are the ones principally used, and, while not the best for the highest classes of work, are made to serve the purpose in many heat treating shops. The efficiency of this method of heating depends largely upon the construction of the furnace. Some furnaces heating slow or fast, as the case may be, others heating uneven. Slow heating means unnecessary loss of time and inconvenience where there is an abundance of work. Rapid and uneven heating increases the danger of overheating the steel, which may cause cracks in quenching from uneven strains. Too much cannot be said against furnaces that

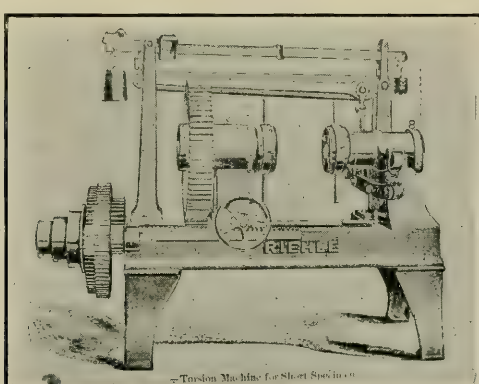
heat unevenly as this, combined with erroneous temperatures, causes a great amount of damage to good steel.

The construction and operation of an even heating furnace costs no more, and in most cases less, than one of poor construction and uneven heating.

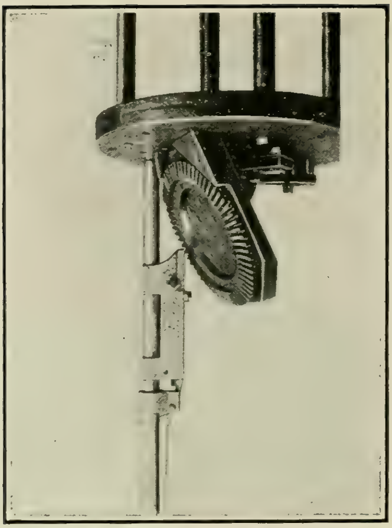
The advantages of uniform heating furnaces are many. They are easy to operate, requiring less attention than non-uniform heating furnaces that necessitate repeated fast firing and subsequently lowering of the flame to allow the colder portions



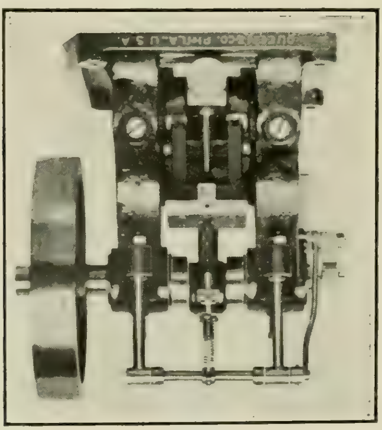
No. 17—One Testing Machine, showing whole spring in position for testing.



No. 19—One Testing Machine for Making Tortion Tests.



No. 20—Hammer Test for Gear Teeth. Cast iron table 20″ in diameter, supported on five steel bars. On a one-inch bar, six feet long above table, is mounted a hammer weighing ten pounds. Different clamping devices are used for different styles of gears. Striking head of hammer is fitted with adjustable tool-steel head, and can be dropped from any height by automatic tripping device.



No. 21—Alternating Impact Testing Machine. Test piece ½″ round by 6″ long. Held securely at one end in vise and moved backward and forward by slotted arm. Distortions produced by impact and bend.

of the steel to attain the same temperature as the portion nearest the flame. They reduce the danger of cracking when quenching. Many have a semi non-oxadizing chamber which is of advantage principally when heating the higher grades of steel.

Advanced Methods of Testing:—

In presenting this subject of heat treatment, remarks upon the different methods of testing alloyed steels, other than those used to determine tensile properties, have been purposely omitted, partly for lack of time and partly on account of limited amount of knowledge on the part of the author. However, I wish to say something that will encourage those interested to make further investigations into this important subject, namely, dynamic testing of steel.

Too much reliance is generally placed upon the limited information furnished by the static tension tests, with the result that numerous failures in practice cannot be accounted for.

It is just as essential to know the behavior of steel when in service as to know what steady load it will sustain without permanent set.

The solution of the heretofore inexplicable failures, due to bad steel or heat treatment, will to a great extent be revealed by dynamic tests. Machine parts should be divided into their respective classes with regard to the direction of stresses applied in commercial use and, in addition to the static tensile tests, dynamic tests should also be applied. A few examples are as follows: crank shafts, transmission shafts, etc., by tortion test. Springs, axles, connecting rods, etc., by the alternating impact test. Case-hardened articles, such as gears, die blocks, roller bearings, etc., by some approved hardness test.

In conclusion, allow me to suggest that first class equipment for heat treating purposes be used—especially, furnaces, pyrometers, quenching and drawing back baths. The cost will be small when compared with results attained. Loss of life, due to lack of proper steel or proper heat treatments, should alone be an incentive to improvements. Small users cannot be expected to install expensive testing machines, but the small expense of having occasional tests made will be money well spent. The equipment will be of little use unless a thoroughly good man is placed in charge. He should direct the heating, keep the pyrome-

ters in good condition, design furnaces, and be eternally busy working out new methods of heat treating which will tend to increase the quality of the articles involved.

PRESIDENT: The question is now before you for discussion. Is Dr. Unger in the room? We would like to have him open the discussion.

SECRETARY: Dr. Unger can not be here and he has forwarded his discussion to me, which, with your permission, I will read.

MR. J. S. UNGER:

Mr. President and Gentlemen:—Mr. Mitchell's excellent paper has brought to our minds a subject in which the majority of those present are directly interested. While he deals primarily with alloy steels, practically all of which must be heat treated to develop their best qualities, he has to a certain extent overlooked the possibilities of the heat treatment of ordinary steels.

It is well known that the ordinary steels make up more than 90% of all the steel made in the United States today. With the exception of the hard or tool steels, which were probably the first steels made by the ancients and which were always used in a hardened or heat treated condition to make them serviceable as tools, we have done very little towards the treatment of other steels until within the last twenty years. With the advent of alloy steels and their attendant higher cost, it was found best to give them such a treatment as would put them in the best possible condition for service.

Such a state of affairs did not exist in the case of carbon steel, as it was the invariable practice, usually from the standpoint of cost, to increase the size of section in order to secure the necessary strength, rather than to attempt any treatment. The increase in the steel rail from 50 lbs. to 100 lbs. within twenty-five years, and the substitution of the steel axle for the former wrought iron axle are familiar examples.

This increase in the size of the rail will go on, but it is certainly to be universally supplemented by heat treatment. It seems almost certain that within a decade the standard rail will be a heat treated rail of 150-lb. section. Manufacturers of railway material are constantly experimenting to produce a more serviceable article. When a manufacturer can assure a railway that he can furnish a treated rail which will give 20% to 25%

greater service and has a factor of safety of an equal amount, at a cost which is approximately the same as an untreated rail of 25% greater section, he will readily find a market for his product.

In the case of the railway car, where the dead load carried is an important consideration, the lighter heat treated material will receive the first consideration. Several manufacturers are in a position to furnish and are furnishing treated railway axles today. An ideal axle must be one of the least weight and possess the quality of being able to resist all the torsional and bending stresses to which it may be subjected in regular service. The average axle in the condition in which it is left after forging, which is the standard practice, may be improved by heat treatment to show 15% greater strength with very little change in ductility, as measured by a tensile test. When examined by a torsion test, which more nearly approaches the actual service conditions, greater differences are shown.

As the steel wheel replaces the cast iron wheel, it will be treated to get the best qualities. The use of the superior steel wheel is growing rapidly and some manufacturers are in a position to furnish treated wheels, which surpass the untreated wheels.

Steel castings enter largely into railway construction. It was not the regular practice to anneal steel castings in the past, but the more important work is annealed today. This form of heat treatment is essential. In annealing, very little strength is sacrificed, while the toughness, as indicated by bending or twisting, has been increased from two to four times that of the untreated casting.

The development of the aeroplane created a demand for an extremely light and strong metal. This want has been met by a series of what may be called Aluminum-Magnesium-Copper alloys, which possess these properties. As pointed out by Mr. Mitchell, a similar state of affairs exists in the material used in the motor vehicle. The demand for a light material of great strength could not easily be met by treated carbon steels, and treated alloy steels were used. The service required of such a vehicle is very severe, and reduction of weight is of primary importance. This furnished an important field for the alloy steels.

As alloy steels are more susceptible to thermal treatment than carbon steels, they must be handled more carefully. To do this work well on either alloy or carbon steel, an edequate equipmet must be provided.

In former years all heat treatment was left in the hands of the blacksmith, forge master or founder. While they could be depended upon to do the best that their knowledge and facilities would permit, they were unable to do such work as might be required in a modern shop today.

The essentials of successful heat treatment are not necessarily an expensive plant, but should consist of uniformly heated furnaces, preferably gas or oil fired, of sufficient capacity to avoid bringing the piece of steel too near the bottom, sides, roof or fire to prevent uniform heating. A pyrometrical installation should be provided of such sturdy construction as to be little likely to get out of order under ordinary shop service. This installation should be inspected frequently by a competent person and kept in good condition, as a poor pyrometer is like a watch which does not keep time. *It should be discarded.*

Above all, the work should be under the supervision of a competent person, who knows what can be accomplished by treatment, and for what purpose the work is intended. Under such circumstances a heat treating shop or plant will pay.

PRESIDENT: May we hear from Mr. George S. Bowes, Superintendent of the Open Hearth Furnaces of the Page Fence Co.?

MR. GEORGE S. BOWES: I remember what the first speaker said about men having courage enough to stand up and talk on a subject, and for that reason I will do my best.

I was very much interested in the discussion, but I do not feel competent to discuss the paper. I came to listen and I am very glad to have had the opportunity of hearing this paper.

PRESIDENT: I might remark that any one who speaks will have opportunity to read what he has said and correct it before it is published. So you need not hesitate to speak. Mr. W. H. Markland, General Shop Inspector, P. R. R., we would like to hear from you.

MR. W. H. MARKLAND: I do not know that I have anything to say. I was very much interested in the paper.

PRESIDENT: I would like to call on Mr. Gustaf Peterson, Vanadium Representative of Carnegie Steel Company, at Philadelphia, Pa.

MR. GUSTAF PETERSON: I was very much interested in coming up here to listen to Mr. Mltcheil's talk on heat treatment of vanadium steel, especially as I am working in the interest of alloy steels in Philadelphia and Boston districts of the Carnegie Steel Company.

Before I say anything in regard to my experience with alloy steel, I would like to say that I believe Mr. Markland, of Altoona, Pa., tried to side-step the issue when he said that they are not doing very much as far as heat treatment of steel is concerned, in Altoona. Until a year ago, I was myself employed by the P. R. R. in their testing laboratory, and for the last four years of my employment there, spent my entire time in development of heat treatment of various grades of steels, especially spring steel; and now, since I left the P. R. R. and have had an opportunity to notice the handling of steel at other plants and railroad shops, I do not believe there is any shop east of Pittsburgh that has gone so far in development of heat treatment of steels, as the Altoona shops, nor has anyone taken such good care of, or getting the best out of their material as they do there at present. This development might be shown by remarking that I started this work myself at Altoona, five years ago, and today they have not only a large force in the testing laboratory but also an organization built up in the shops to take care of the heat treatment of steels.

What really started the P. R. R. in the heat treating game was the continuous trouble they had with their locomotive springs. The amount of repairs to driving springs made at Altoona went into the thousands of pounds in twenty-four hours, and it was realized that something had to be done to stop the breaking of their springs. The railroad company sent me out to the various spring manufacturing plants to follow up their practice and see if we could learn something. I found that in most of the plants, the steel was heated to any temperature, formed into spring leaves, and then quenched in oil. They were not at all particular as to the temperature for the quenching, which might be white heat or a low red heat at one end and black at the other. The consequence was they got springs of all kinds,

as far as treatment was concerned. One leaf might come through the process all right, the next one might be too soft and the third one might be entirely too brittle, which condition, of course, must influence the working of the spring; the brittle leaf would break, the soft would set and the spring was ready to go to the repair shop.

When I came back to Altoona, we took the matter up from a laboratory standpoint and made a number of experiments until we found the exact treatment for the steel. We then designed a furnace in which we could obtain a uniform heat, and started to heat treat our spring by scientific methods. When I left the P. R. R., December a year ago, they had repaired and sent out on the road about 800 pairs of driving springs, all of which had been marked and were carefully followed up in the road service. They had then so far, only two failures, and both of these on examination were found to be due to a defect in the steel, produced by overheating during the first treatment at the manufacturer's works. I must mention that all these experiments and work were done on repairing springs, as Altoona did not manufacture new springs to any great extent.

I understand that the good success they had there with spring steel under scientific treatment has led them to go into the heat treatment of steel for a number of other purposes, such as axles, crank pins, side rods, etc., and that they are now installing a heat treatment equipment for this purpose at the Juniata Shops. So much for the improvement which can be gained with the ordinary carbon steel under scientific treatment.

Since joining the Carnegie Steel Company, I have, of course, entirely devoted my time to the interest of Chrome Vanadium Steels, and we certainly have found that by using this alloy steel we cannot only meet the physical properties of carbon steel in its very best heat treated condition, but far exceed the same. I have been trying to interest the railroads in the use of alloy steel for springs, axles, side rods, crank pins, etc., and while we have had good success with all these locomotive parts, our spring steel business has been the most prominent one. We have proven to the railroads that we can make Chrome Vanadium Springs which will give them at least double the life of the carbon spring, while working under much higher fibre stresses. I know in one instance where a guarantee was made to a railroad on Chrome

Vanadium Springs for four times as long a period as is usually guaranteed for the ordinary carbon spring. This railroad equipped twenty of their new locomotives with Vanadium Springs and they have now been in service over half of this guaranteed time, without a single failure, and I believe they will stand up during the remainder of the contract time and long after same has expired.

In heat treating elliptical railroad springs, we aim for an elastic limit of 170,000# per square inch, and the leaf of these springs will bend at least 90 degrees over 1″ radius, without breaking, a feature which cannot be done with the carbon steel, even when scientifically heat treated. This would certainly prove that in a case of emergency a vanadium spring is much safer than a carbon spring. The fact that a carbon spring cannot be treated to have over 140,000# elastic limit, while the chrome vanadium spring treated to, as already said, 170,000# elastic limit, shows in case of overloading, the vanadium spring will recover itself, whereas the carbon spring will either break or take a permanent set.

We all know that railroads have had considerable trouble with their coil springs, and the Carnegie Steel Company has lately been working on the proper type of chrome vanadium steel to be used for this purpose. A coil spring made from carbon steel has usually a fibre strain of 80,000# per square inch when solid. We have been trying to procure a chrome vanadium spring which will be solid under a fibre stress of 120,000# per square inch, and yet carry the load of the present carbon spring and give a longer life.

The result of our experiments makes us believe we can do this, and if what we have found by these experiments will be true in the road service, it will be possible for us to reduce the diameter of the wire in the coils and procure for the railroads a spring of lighter weight, with less breakage and longer life, which will in turn make the difference in price between a spring made from chrome vanadium steel and one made from carbon steel so small that we can offer it to a good advantage to the railroads and receive their business.

PRESIDENT: Mr. H. M. Barnes, Engineer of Tests of the R. D. Nuttall Co.

MR. H. M. BARNES: I am like the other gentlemen who

have just been called on; I came to listen, not to talk. I must agree with Dr. Unger that the carbon steel requires a lot of consideration in that treatment. Alloyed steels are more susceptible to treatment, but there are very few of us buy it in general work. The author rather inferred that the electric pyrometer is not as good as the Siemen's water pyrometer. I think if proper care is taken it will compare favorably for accuracy, and it is much more convenient.

PRESIDENT: Is they any representative of the Carbon Steel Co. present? Can we hear from Mr. J. D. White, Pittsburgh Sales Manager of the Crucible Steel Co. of America?

MR. J. D. WHITE: I have enjoyed the paper very much. It is both interesting and instructive. I have really no comments to make on it as I think it covers the ground thoroughly.

PRESIDENT: Mr. Redding, Assistant Superintendent of Motive Power, P. & L. E.

MR. D. J. REDDING: I do not profess to know much about alloy steel, but feel that I am gaining valuable information tonight. I was very much interested in what the speaker said about heat treatment for crank pins, axles, and other locomotive parts. I am free to say that I have not given that subject any consideration whatever in our work. We sometimes have crank pins break off irrespective of the large diameter which they have reached.

Judging from what I have heard tonight, it would seem possible to prevent or delay these breakages, and I would like to ask whether the elastic limit of steel, such as used in these large crank pins, 9 or 10″ in diameter, can be increased by any certain percentage, say 25 or 30%?

I would also like to ask the speaker if any consideration has been given to the use of chrome vanadium steel to replace wrought iron or ordinary steel for bushings and pins, such as used in valve motion, parallel rods, and other parts that wear out rapidly.

Where wrought iron is used for bushings and pins, it is necessary to case-harden it, which means quite a long delay in the handling of the parts. If this better grade of steel could be used and pins and bushings turned up, hardened, and put into service on the same day the engine is held for repairs, it would avoid

the delay on account of time taken to case-harden, and should make quite a saving in time lost by locomotives.

The matter of protecting parts of gears, or other machinery, which it is not desired to harden while hardening other sections of the same parts, is a subject which seems to be receiving a great deal of expert attention in the past few years. I understand that one very good method is to copper-plate the portions which are not hardened, and notice that this practice is followed largely by the pneumatic tool people.

MR. MITCHELL: The elastic limit of heat treated chrome vanadium steel is 25 to 50% above that of untreated carbon steel, used for locomotive pins.

Case-hardening of valve motion parts, bushings and pins has been largely discontinued, which tends to increase the wear. Several conditions have contributed to the abandonment of case-hardening. Some that could be mentioned are: delay, incurring loss of engine from service, also difficulty of getting wrought iron of suitable quality to case-harden; much wrought iron being too seamy for this purpose.

Chrome vanadium steel offers a practical solution of the problem. Without case-hardening, it responds perfectly to heat treatment, giving the necessary hard wearing surface, which is the only advantage of case-hardening wrought iron; also great strength combined with toughness.

Type A full chrome vanadium steel which contains .30 to .40% carbon, .40 to .60% manganese, .60 to 1.00% chrome, and .16% or over vanadium, heated to 900 degrees centigrade and quenched in oil, and drawn back from 650 to 675 degrees centigrade, will show about 80,000 to 90,000 lbs. per sq. in. Elastic limit, 100,000 to 125,000 lbs. per sq. in. Ultimate strength, 20% elongation and 40% reduction. A bar 1″ in diameter or a specimen ½″ square of above physical qualities will bend double upon itself without showing rupture of the steel.

Many locomotive shops are using chrome vanadium steel in their repair work. The American Locomotive Company is using it regularly repairing all parts subjected to severe conditions.

Having had no experience in copper plating of machine parts which are not to be hardened, I cannot answer that part of Mr. Redding's inquiry, but will refer him to Mr. Buechner,

who represents E. F. Houghton & Co. Possibly he can give us some information on this subject.

MR. W. A. BUECHNER: To obtain certain results after carburizing, it is merely a question of heat treatment. If hardness only is desired, one re-heat is sufficient, but if hardness and toughness combined is required it means a different method of heat treatment.

MR. H. L. CLARK: Excuse me, but I believe that Mr. Buechner did not quite catch Mr. Redding's question. There are a number of methods of preventing certain parts from carbonizing in the case-hardening process, but the one most used and the cheapest is to cover such parts with fire-clay.

MR. BUECHNER: I did not get Mr. Redding's question. As Mr. Clarke says, to keep pieces from taking the carbon in certain places, some people pack these spots in fire-clay, and if the fire-clay is mixed with a little asbestos wool better results will be obtained, for the mineral wool keeps the fire-clay from baking away from the part. I also understand there is a paint made for this purpose.

As this is a discussion of the heat treatment of steel it might be interesting to go a little further into the subject of case-hardening.

Case-hardening means the infusion of carbon for the purpose of obtaining a hard surface to wrought iron, low carbon steel, and alloy steels of low carbon contents, leaving the inside soft, and their uses are best adapted to parts such as gears, pins, dies, roller bearings, bushings, and the link motion for locomotives. In fact, to any parts requiring any extra hardening to withstand wearing and where toughness, elasticity and resistance to shock is also required, this result can be best obtained only by proper case-hardening and heat treating. In fact, we have two concerns who are using low carbon steel for making reamers, milling cutters, and other machine shop tools, and carburizing them, getting better results than were formerly obtained by using high carbon steel.

The alloy steels give the best results when case-hardened, owing to their being more susceptible to heat treatment; they giving a finer structure and finer grain in the case. Low carbon steels are the best for case-hardening for the reason that the

lower the carbon in the steel to begin with the more it will absorb in the treatment and leave a tougher core.

It may be well to add here that all my remarks refer to pack hardening method.

The parts to be case-hardened should first be machined very close to size so that very little will have to be ground off to make the fit. In fact, if properly handled there will be so very little distortion that very little grinding will have to be done after carburizing except in cases of bushings or light parts which must be absolutely to size. A little stock, possibly 1/64", must be allowed for grinding.

The boxes should be proportionate to the size of the work to be done to save time in heating. The pieces should be packed in the carburizing compound a little apart to enable the carburizing gases to circulate around them. The heat to run at and the time depend on the size of the box, the size of the work, and the depth of the case desired.

After the pieces are carburized they should be allowed to cool in the boxes; then it depends on the results desired as to how the parts should be heat treated. If hardness alone is desired, one re-heat is sufficient. To do this put the parts in the furnace and heat them up to 1350° to 1450° F. Be sure you do not have a decarbonizing flame. Then quench in oil or water, depending on hardness desired.

If, however, toughness as well as hardness is desired, the parts should first be heated to 1550° to 1650° F. This heat depends on the carbon in the steel in its original state and also if it is a carbon or alloy steel. The pieces should then be quenched in oil, then reheated from 1350° to 1450° F and quenched in oil or water.

The first reheat refines the core on the inside, but the outside or the case, being a high carbon steel, this high heat does not leave it in the best of condition, and for this reason it is necessary to have the second heat treatment at a lower temperature, as explained before.

MR. MARKLAND: As to the copper plating of the part not to be case-hardened, they put on the copper plating and remove the copper plating where they wish it case-hardened.

PRESIDENT: Mr. Stucki, have you anything to add?

MR. A. STUCKI: I came here to listen, and I have listened with a great deal of interest.

The subject of this evening is heat treatment of alloy steels. This means heating, cooling and reheating the material, a merely physical process, by which the structure of the material is improved and by which the internal strains are removed without, however, changing the chemical composition.

Case-hardening iron or steel, on the contrary, is a chemical process, by which the surface of the material is forced to take on a good deal of carbon, with the result that we get a very hard surface.

Steel in general, be it alloy or carbon steel, be it rolled or cast, is an excellent material in many ways. It can be treated and improved by many different methods, and as the speaker pointed out, its structure can be improved in a very inexpensive way, so that its strength is from 25 to 50% greater than in its original state.

Some seven or eight years ago I went through a series of experiments made and published in England, where by testing several thousand test pieces the fact was established that, by heating, quenching and reheating, the limit of elasticity and the ultimate strength was very much raised without affecting the ductility hardly any.

I then went through a similar series of tests with steel castings, taking samples from different foundries, also of different chemical composition, and varying the different heats from 600 degrees centigrade to 1000 degrees centigrade, cooling in air or water, and reheating to different degrees. I found, just as Mr. Mitchell did with alloy steel, that by heating to about 900 centigrades, quenching in water and reheating to about 400 degrees centigrade, improved the strength about 40%.

Such additional heat treatment could be done in a very inexpensive way. All we need to do is to rig up for it properly and the reason for it not having been done before, is possibly the fact that steel is an excellent material, even in its original state, but the time will surely come when this means of improving the steel will more generally be used.

Mr. Mitchell spoke about dynamic tests. There is a great difference between a dynamic test and a mere rotative test. In the latter case, we merely subject the material to tensile and com-

pressive stresses alternately, and we should not call it a dynamic test, because we do not produce shocks and blows, such as are set up in actual service.

For this reason I doubt whether the test described is the proper one for springs. In reality, a spring is subjected to jerks, blows and recoils, while with the rotative test we do not get any such effect.

One other thing: The wheel, and especially the desire of getting a hard tread, has been mentioned. The ideal wheel must have a very hard tread, fairly hard flange and a tough body, and my opinion is that ultimately we will carbonize the rim and decarbonize the body at the same time we anneal the wheels. In that way I think it may be possible to get an ideal and also an inexpensive wheel.

MR. MITCHELL: Mr. Stucki says that a spring should not only get a deflection, but it also should have a blow at the same time to make the test parallel. That is exactly what the alternating impact test does give. The test piece receives impacts and is deflected repeatedly.

With regards to wheels: For several reasons it would be impossible to carburize a wheel and harden it. First, the expense incurred in carburizing would keep it from being a commercial proposition. Second, the danger of spauling the tread or breaking the flange due to increased brittleness. Third, spauls would mean re-turing to eliminate them, and this could not be accomplished, as the remaining carburized portions would be too hard.

MR. STUCKI: I would like to ask one more question: If you get a hard tread by heat treatment, don't you run the risk of losing the temper, or whatever it is, in getting a hot wheel running down a long grade? Further, you also said that it is not feasible to make a tread hard enough so as not to be able to be machined. I should think if you could do that it would be an advantage, because we do not care about machining wheels if we can get them hard enough so they will last without re-turning.

MR. MITCHELL: Case-hardening of the wheels would be a very expensive process, for one thing. And then again, you have to consider the danger of getting the flange too hard. We know what might happen if the flange should break in service. The flange and the tread being so close together, it would be a

delicate operation, either by carburizing or quenching, to get the proper hardness on both the tread and flange.

MR. A. W. CROUCH: I am sure all present have enjoyed this most interesting paper. Therefore, I would suggest that we offer a vote of thanks of the Club to the speaker in appreciation of his paper.

The motion was duly seconded and carried by unanimous vote.

There being no further business

ON MOTION, Adjourned.

J. B. Anderson
Secretary.

In Memoriam

M. A. MALLOY

DIED NOV. 3, 1912

In Memoriam

C. L. HINSDALE

DIED DEC. 10, 1912

OFFICIAL PROCEEDINGS
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TERMINAL SERVICE

BY W. M. PRALL, SUP'T OF CAR SERVICE
PENNSYLVANIA LINES, PITTSBURGH

INDEX—ADVERTISERS.

OFFICIAL PROCEEDINGS

OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, JANUARY 24th, 1913.

The meeting was called to order at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M., with President A. G. Mitchell in the chair.

The following persons registered:

MEMBERS.

Alleman, C. W.
Allison, John
Amsbary, D. H.
Anderson, J. B.
Angell, C. P.
Altman, C. M.
Bennett, R. G.
Bihler, L. C.
Bond, W. W.
Boyer, Chas. E.
Brand, Thos.
Buechner, W. A.
Buffington, W. P.
Byron, A. W.
Chittenden, A. T.
Clark, C. C.
Clifford, M. J.
Cline, W. A.
Cole, Jewett
Courson, C. L.
Courtney, D. C.
Crouch, A. W.
Dunlevy, Jas. H.
Eichenberger, J. J.
Falkenstein, W. H.
Ferren, Robt. O.
Fitzgerald, D. W.
Forsythe, Geo. B.
Frazier, E. L., Jr.
Garaghty, W. C.
Gies, Geo. E.
Gillespie, W. J.
Glassburn, S. G.
Gulick, Henry
Harriman, Henry
Hawthorne, H. J.
Herman, W. J.
Herrold, A. E.
Howe, D. M.
Hurley, Theo.
Ickes, E. T.
Haynes, J. E.
Kinch, L. E.
Kinter, D. H.
Kelly, H. B.
Kessler, H.
Knickerbocker, A. C.
Knight, E. A.
Lewis, A. J.
Lynn, Saml.
Lyle, D. O.
Maxfield, H. H.
Mensch, E. M.
Miller, F. L.
Mitchell, A. F.
Mitchell, A. G.
McAbee, Wm. S.
McCartney, J. G.
McCleary, G. T.
McFeatters, F. R.
McNaight, A. H.
McNulty, F. M.
Neely, J. L.
Newbury, E. H.
Newman, L. L.
Obermeier, H.
Orchard, Chas.
Orner, M. T. S.
Perry, W. E.
Pfister, O. J.
Phillips, Lee
Porter, C. D.
Porter, H. V.
Pyle, P. S.
Rabold, W. E.
Redding, D. J.

Robbins, F. S.	Snyder, F. I.
Rohn, M. R.	Steele, W. K.
Rohn, W. B.	Stein, J. J.
Ryan, Wm. F.	Stevenson, R. F.
Schaffer, R. H.	Stucki, A.
Schauer, A. J.	Suckfield, G. A.
Scheck, H. G.	Swope, B. M.
Schoonover, W. H.	Taylor, F. C.
Shade, H. M.	Thomas, E.
Shallenberger, C. M.	Thurlby, A. R.
Shook, A. A.	Tucker, J. L.
Shremp, J. A.	Walter, W. A.
Searles, E. J.	Walker, J. W.
Smith, E. B.	Walther, G. C.
Smith, John H.	Ward, R. H.
Smith, John	Warnock, H. R.
Smoot, W. D.	Weir, R. M.

Wendt, E. F.

VISITORS.

Abel, J. W.	Green, H. M.
Adams, Geo. H.	Haselett, D. H.
Barron, E. T.	Hawkins, R. H.
Bernstein, Wm.	Hipple, H. M.
Biles, E. M.	Hooper, R. E.
Billhimer, F. A.	Hoover, H. D.
Blair, Geo.	Huggins, J. H.
Blair, W. A.	Kane, H. S.
Bowden, J. J.	Kensinger, E. A.
Boyle, H. E.	Krahmer, E. F.
Burrell, J. E.	Latimer, W. B.
Camlin, A. D.	Lewis, M. K.
Chalfant, J. F.	Marquis, E. M.
Clowes, W. K.	Melville, L. B.
Connors, J. H.	Moore, H. Lee
Craig, G. S.	McCracken, C. M.
Cribbs, O. L.	McKee, W. L.
Cuthbert, E. L.	Nickerson, S. N.
Deneke, W. F.	Prall, W. M.
Duggan, E. J.	Reed, W. A.
Dygert, W. B.	Rees, H. S.
Earle, J. A.	Riggle, E. W.
Fleck, V. H.	Robinson, W. H.
Flocker, N. J.	Rohn, T. R.
Fry, J. G.	Rush, Geo. W.
Garland, W. L.	Scott, T.
Grafinger, Jos.	Sheets, H. E.
Grathow, H. M.	Shelton, J. T.

Sherman, J. K.	Very, P. G.
Sloan, Alvin	Wagner, P. R.
Smith, R. J.	Welty, Isaac B.
Sorrick, Geo. B.	Wittig, Wm.
Spottswood, H. L.	Wood, V. V.
Stinemetz, W. R.	Zeigler, E. E.
Zink, W. H.	

The call of the roll was dispensed with, as the registry cards furnish the record of attendance.

The reading of the minutes of the last meeting was dispensed with, as they are in print.

The Secretary read the following list of applicants for membership:

Babcock, F. H., Asst. Foreman, P. & L. E. R. R., 938 West Carson Street, Pittsburgh, Pa. Recommended by John B. Smith.

Barron, Edward T., Inspection Dept., Carnegie Steel Co., 671 Frick Annex, Pittsburgh, Pa. Recommended by Elwood T. Ickes.

Brewer, Wm. A., Mechanical Engineer, Standard Railway Equipment Co., Frick Bldg., Pittsburgh, Pa. Recommended by R. B. Woodworth.

Cassiday, C. R., Chief Clerk to General Manager, W. P. T. Ry., 419 Wabash Bldg., Pittsburgh, Pa. Recommended by D. M. Howe.

Camlin, A. D., Freight Agent, P. R. R. Co., East Liberty Freight Station, Pittsburgh, Pa. Recommended by F. L. Miller.

Code, J. G., General Manager, W. P. T. Ry., Wabash Bldg., Pittsburgh, Pa. Recommended by D. M. Howe.

Deneke, W. F., Freight Agent, Pittsburgh Div., B. & O. R. R., 593 Jones Ave., North Braddock, Pa. Recommended by C. P. Angell.

Dygert, W. B., Jr., Asst. on Eng'r Corps, P. C. C. & St. L. Ry., 1013 Penn Ave., Pittsburgh, Pa. Recommended by C. M. Shallenberger.

Garland, W. L., Manager, Safety Car Heating and Lighting Co., 501 Arcade Bldg., Philadelphia, Pa. Recommended by H. V. Porter.

Ingold, C. F., Clerk, P. R. R., 318 Penna. Station, Pittsburgh, Pa. Recommended by W. K. Steele.

Kensinger, E. A., Freight Agent, P. R. R. ,Greensburg, Pa. Recommended by F. L. Miller.

Laughlin, E. J., General Foreman, P. & L. E. R. R., McKees Rocks, Pa. Recommended by H. B. Kelly.

McNary, F. R., Car Distributor, P. R. R., Derry, Pa. Recommended by H. M. Miller.

MacQuown, H. C., Car Tracer, P. R. R., 1502 Wood St., Wilkinsburg, Pa. Recommended by A. D. Gilbert.

Neal, John T., Special Fireman, P. R. R., 7159 Mt. Vernon St., Pittsburgh, Pa. Recommended by W. L. Hudson.

Partridge, F. G., Storekeeper, P. & L. E. R. R., McKees Rocks, Pa. Recommended by C. W. Alleman.

Ross, Coleman B., Salesman, Independent Pneumatic Tool Co., 1208 Farmers Bank Bldg., Pittsburgh, Pa. Recommended by Geo. A. Gallinger.

Scott, Thirlestane, Asst. on Eng'r Corps, P. C. C. & St. L. Ry., 1013 Penn Ave., Pittsburgh, Pa. Recommended by C. M. Shallenberger.

Sinclair, C. F., Draftsman, Power Dept., Jones & Laughlin Steel Co., 3612 Dawson St., Pittsburgh, Pa. Recommended by H. L. Goetz.

Wible, Edwin F., Master Mechanic, Foundry Dept., Pressed Steel Car Co., 923 Middle St., Avalon, Pa. Recommended by E. L. Antes.

Wood, Valentine V., Clerk, P. R. R., 318 Penna. Station, Pittsburgh, Pa. Recommended by W. K. Steele.

PRESIDENT: These names will be referred to the Executive Committee, upon whose favorable report the applicants will become members without further action.

Is there any further business to come before the Club? If not, the next in order will be a discussion of the subject, "Terminal Service," by Mr. W. M. Prall, Superintendent of Car Service of the Pennsylvania Lines, West of Pittsburgh:

MR. W. M. PRALL:

TERMINAL SERVICE.

BY W. M. PRALL

Sup't. of Car Service, Pennsylvania Lines.

Mr. President and Gentlemen:—At the December bi-monthly meeting of the Traffic Club of Pittsburgh, two of the principal speakers were Professor Davis, of the Pittsburgh Normal Training School, and Professor Greene, the Dean of Westchester Normal, and I was particularly impressed with their remarks, because, evidently without consultation, each one chose as his theme the broadened conditions surrounding the development of nations, and the necessity for giving consideration to the dreamer.

Professor Davis dwelt upon the development of the immigrant, and the strides they were making because of their intense desire to attain knowledge, with the possible outcome of their final leadership, unless the American stock dreamed more, and put the "punch" behind the dream.

Professor Greene, in the course of his remarks, referred to the Declaration of Independence in 1776 (the declaration of our material independence) and then referred to Ralph Waldo Emerson's declaration of intellectual independence in 1837, and then to the dreams of Franklin, which resulted in our knowledge of the electric spark, and to the dreams of Edison and Marconi, quoting a remark of Edison's that even at the best, the sum of our present knowledge was small, and possibly did not equal 1/7000 of 1/7000 of one per cent. of knowledge.

Professor Greene, continuing his remarks, referred to the dream which resulted in the erection of the now well-known Pennsylvania Railroad Station in New York, and I wondered if it were not possible that some other president of a railroad would not soon dream to the end of the development of a terminal for the proper handling of freight cars. A terminal so organized in harmonious relationship with other terminals that service shall be worked out to a final adjustment, resulting in the prompt movement of cars into, and out of, the terminal. Into the terminal for delivery on tracks for unloading if the

terminal is the final destination, and through the terminal if the obligation for service requires the delivery of cars to connecting lines.

The terminal problem is not a new problem, and James J. Hill, years ago, in one of his speeches asserted that the railroad problem of the future was the terminal problem.

The Interstate Commerce Commission, in some of its later rulings, has indicated that it is carefully studying the terminal to the end of the introduction of proper rules and regulations that will hold everybody party to the contract to inter-dependent responsibility.

The road organization of almost all railroads has been worked out with a certain degree of uniformity, but it is to the contrary with terminals. There is no comprehensive organization at the terminals. The service at the terminal, though of equal importance, is worked out individually at each terminal, there being a wide divergence of methods at the various terminals.

In order to attain improved car movement, it is necessary that the two services should be developed along harmonious lines, so that, whether the road department delivers to the terminal, or the terminal to the road department, there should be a continuous control over the individual car.

The terminal has been likened to the neck of a bottle: No matter what is the capacity of the bottle, it can only be filled or emptied in accord with the flow through the neck. If there is any obstruction in the neck, or any obstruction in the terminal, movement ceases.

A number of years ago, I maintained that the railroad should appreciate the fact that the terminal was a great deal like the first and last processes in a manufacturing plant. No matter what may be the efficiency of the intermediate machinery, that efficient machinery is valueless unless the manufacture is begun and continued to final completion, so that the product is marketable and can be placed in a market at a reasonable profit.

Although it is true that every car that is loaded is not handled in, or out, or through a terminal, yet the fact remains that using the car as a unit, there are more terminal movements than there are car units, and, as every movement is an independent movement, switching being performed as per the instruc-

tions exhibited on the way-bill, and transferred by records to the agent and yard master, any delay in the transfer of instructions results in delay to the car.

We all know that a railroad is obligated to receive freight when it is accompanied by proper billing instructions, with the further obligation for transporting all freight in a reasonable manner to billed destination; transportation being followed by the placement of the car in a reasonable position for unloading, and that the railroad, to the end of protection of its revenue must introduce such rules and regulations as will protect the revenue and establish the record of delivery. Cars moving between stations in road service are accompanied either by revenue billing or card way-bill. They are in trains in charge of conductors, but when they arrive at the terminal the car is no longer accompanied by the way-bill. Therefore, the necessity for an organization to the end that the contract referred to may be carried out within the minimum time, or there is increased expense to the railroad.

The first problem, therefore, at the terminal is the organization of a system of records that will in no way delay the car in its movement, but will convey the necessary information to the end of a check, so that the agent can instruct for, and later establish delivery, it always being understood that the agent's instructions must be transmitted to the yard master. Therefore, I have maintained that the first necessity to the end of terminal service is the establishment of a record for the use of the agent in charge, the agent being held to responsibility for the conveyance of all necessary information to the yard master and his subordinates, with one object in view—the continuation of service to the end of the fulfillment of the railroad's obligation for transportation.

My thought has been that the terminal should be organized in harmonious relationship to the organization of the road department; that each terminal should have an independent organization, reporting to an independent head, he reporting directly to the General Manager.

In road service, there is a complete system of reporting. In terminal service the system of reporting is incomplete, and as a rule the reports are made to, or through the road official. It has been demonstrated that by the introduction of a proper record

book at terminals, in which are entered each and every day every car received for local delivery, and every car received with the privilege of distribution, or reconsignment, or reshipment, with the proper checking and reporting, that if salaries are established to the end of the employment of intelligent car service clerks and delivery clerks, that an ever-present supervision has been maintained over the movement of the car, the yard master receiving the necessary instructions for switching. And there is no reason why a system could not be established where every car in through service, handled in the terminal, and every car handled through divisional points, could not be recorded and checked, so that any car delayed beyond 24 hours will be reported delayed, with an additional report of all cars delayed beyond 48 hours, to be made to the central offices.

Your worthy president, through actual supervision of the movement of cars in his territory, determined some seven years ago that a proper check of cars to the end of reports to his yard masters and train masters at local points, materially reduced the expense of the switching service on his division, finally realizing that if he could develop engine delay amounting to 30 minutes a day, that he was justified in employing a sixty dollar clerk to make the necessary check and convey necessary information. And I have in mind another superintendent who fully realized that, as the delivery clerks could not be constantly supervised, it was necessary, to the end of his conservation of switching expense, to employ intelligent clerks and pay them a proper salary, with the full understanding that once employed they could not be transferred for one year.

This superintendent, and a number of other superintendents, have always agreed with me that "Jim" Hill was right. That the service of the railroad in the terminal would never be satisfactory until the terminal is organized, and in the organization of the terminal the necessities of the patrons of the terminal should be fully understood. That they must be studied, and there must be a system of records which will enable the official in charge to properly supervise the movement of cars in the terminal.

During the last twenty years there has been a gradual improvement in the understanding of terminal necessities, and here and there throughout the country we find terminals in

charge of a general agent, or in charge of a superintendent of terminals, they having authority over the entire terminal; not only in authority as the representatives of the comptroller or auditing department for the collection of moneys, but in authority over the terminal organization. And we also find on the independent belt lines a better understanding of the possibilities of service. But, in neither the terminal or on the belt lines do we find a uniform understanding of the possibilities of improved service through the practical application of the demurrage rules that are common at the present time to the whole country.

The greatest failure in the understanding of the demurrage rules by the railroads at terminals, is their failure to understand the benefits that can be derived in improved service by the constructive placement of cars. It is the pressure on the car already placed, to the end of that car's unloading, that results in continuous movement of the car and relieves congestion not only at the terminal itself, but on the division of the railroad feeding the terminal.

But, granting that the railroads have not fully realized their obligation to complete their terminal organization, it must be remembered that the railroads themselves are badly handicapped because consignees are protected by present laws, and by officials in many States, in their insistence that all the obligation for service is with the railroad, there being a failure to understand the inter-dependent relationship in the entire movement of the car. And a car moves on a private siding just as well as it moves in the terminal or on the main line, and the car cannot move properly on the siding unless the siding is properly organized; unless the consignee has so prepared his siding with roadways, runways, warehouses, etc., to unload the car within the physical time necessary for its unloading. It is the failure of everybody in inter-dependent interest in service to appreciate the fact that everyone must do the best they can to remove the bar from the continued movement of the car, and consignees should not be protected in their demands for supplementary service that was not contemplated in the original contract; that consignees should realize that unless a car can be immediately placed, there must be one or two additional switches, and that the general public bears the expense of those additional switches.

Consignees haven't the right to demand that the railroad should supplement their deficiencies, and consignees should remember that, in accord with the up-building of their own business, in accord with the increased volume of business transacted, they must improve the conditions surrounding their sidings; that a business that increases its output 20, 40, 50 or 100 per cent. without an increase in the facilities for loading and unloading, is adding a burden to service; a burden that should be accepted by themselves, and if accepted by themselves would result in benefits to themselves. The old insistence that because of the volume of business being of importance to the railroad, the railroad should perform additional and unwarranted service, should be fully exploded, to the end of an understanding and of rulings, and, if necessary, of laws denying that additional service at the regular rate.

To me it seems as if rebating has been eliminated, excepting in relationship to unwarranted and supplementary additional service, and it is my thought that it should be as well eliminated in additional service as in repayment of moneys under the old dispensation.

I have noted with a great deal of interest, that the Interstate Commerce Commission, in its later rulings, has exhibited a knowledge of certain conditions surrounding terminal service that is most gratifying. Witness their decision in the Detroit Reconsigning Case. Witness their decision in the California Case. Witness their decision which applied purely to the interchange of cars between railroads, in which they stated that a railroad was obligated to perform its service in accord with the contract, making deliveries to connecting lines even where the connecting line fail in an appreciation of the rights of ownership in the car, and notifying the railroads that they must formulate some rule or regulation to the end of re-taking their cars. The railroads, so far, have been unable to formulate that rule or regulation, and it is because of the inter-dependent relationship in the interchange of cars between railroads, and the inter-dependent relationship between the railroad and its patrons, with the further obligation that the railroads must furnish cars for loading to all points exhibited in their regular and concurrent tariffs, that I hope the Commission will finally realize that in conducting their investigations to the end of determining just

what the existing conditions are, they must not only investigate the service as towards the consignee, but the service in interchange of cars between railroads, particularly in relationship to the interchange of cars under the Per Diem Rules as recommended by the American Railway Association.

The Per Diem Rules pre-suppose that each railroad will deliver cars to each of its connections on tracks arranged for, known as interchange tracks. That is, that each railroad will have a track upon which to make delievery of cars billed through to connections. If each railroad has a track for delivery to connections, there will be two interchange tracks, and there ought to be two interchange tracks if the volume of business warrants it. If not, then there should be thoroughly defined rules in relation to the use of one interchange track, and if it is impossible to arrange for actual physical connection, the railroads being forced to deliver through or over intervening switching rails, the delivering line running through the connection and placing cars in the yard of said connection, then the responsibility of the receiving line in regard to reasonable facilities for receipt of cars should be defined.

The American Railway Association agreement provides that each railroad must place cars on the interchange track accompanied by interchange report to be signed by the agent of each company; the cars must pass inspection, and must be accompanied by proper data for forwarding. Any failure on the part of the railroad to so arrange that cars will move continuously, results in congestion on the tracks of the delivering line, bars the free movement of cars, and decreases the possibility of car efficiency.

At the present time, many terminal engines are delayed from two to six hours because of the failure of the connecting line to so arrange that when the delivering line runs through the connection to the end of placement of cars on the tracks of the receiving line, there are no tracks on the receiving line on which the cars can be immediately placed.

There is another bar to the movement of cars through terminals, and that is the unnecessary detention to cars that are refused by the consignee. The railroad has transported the cars in good faith, fulfilling the contract obligation. Consignee refuses the car. The agent notifies the Freight Claim Agent,

who takes the matter up with the shipper, and before disposition is provided for, the car remains on track 10, 20, 30, 50 and 100 days. Very often the shipper abandons the car. Very often it is impossible to obtain a positive refusal of the car, or a definite abandonment of the car, the final result being a long delay to the car before the sale of the lading.

The laws of many States prohibit the sale of lading until after the same has been duly advertised for a long period of time.

There is another prolific source of car delay, and that is through the present methods of commission men handling perishable freights, who assume the right to withhold cars from the market, always provided the car is held on a rising market, there being authentic cases of delays of 10, 20, 30, 40 and 50 days, the delay resulting in increased expense to the railroad, the shipper and the general public, and additionally resulting in the marketing of the lading after it has deteriorated in food value.

It is my thought that if the shipper was relieved from responsibility excepting for the gathering, draying and loading, and if the consignee was held to responsibility for the immediate payment of freight charges, and in case of failure to pay that the railroad should be held to responsibility for the sale of the lading for whoever it might concern, the result would be a larger consumption of fruits and vegetables, to the benefit of the health of the general public, and it would conserve the interest of the shipper—because his consignments would be sold while they were still marketable—and would conserve the revenue of the railroad, in exchange for which the railroad would be forced to perform additional service as salesman for all parties in interest. Without exception, all officials in charge of terminals know that there are many cars delayed each year until the lading is decayed, the billed consignee denying his responsibility because of his ultimate refusal of the car.

The courts, in sustaining the right of the railroad to make a demurrage charge, have invariably sustained the rules because of the interest of the general public. They have ruled that a demurrage charge is an accessorial charge, and it cannot lie unless the transportation obligation has been fulfilled, and the car has been properly tendered to the consignee; the consignee then de-

laying the unloading beyond a reasonable time, becomes subject to a reasonable charge, which is in the nature of a penalty for breach of contract. And it seems to me that the same principle could be maintained when giving consideration to hygienic necessities, and the marketing of perishable freights within a reasonable time after the railroad has performed its obligation for transportation and made proper tender to the consignee.

Something must be done, because, under present conditions, it is hardly possible that the railroads can maintain their relative relationship to the increased tonnage which is being offered them. The prosperity of the United States is dependent upon the movement of the products of the United States, whether agricultural or manufacturing. No country was ever prosperous that failed in developing its transportation agencies, and no country was ever prosperous prior to the days of steam except the country whose channels of trade lay along the rivers, the seas and the oceans. Reasonable transportation before the days of steam was entirely dependent upon water grade conditions. Steam provided a means for the development of roads that could serve the uplands, and the development of the railroads of the United States has equalized conditions throughout the whole United States.

But, in the early days of the twentieth century, it becoming plain to the people of the country that it is not only the railroads that must be developed to the end of caring for the transportation of lading, but it is also the rivers, and both must be developed along intelligent lines to the end of an understanding of needed service, and the protection of the transportation agencies as long as they maintain reasonable service, with a further understanding that the law of contract must prevail, and that the underlying obligation of all parties in interest is the old Cartage or Drayage Law, upon which is superimposed congressional and legislative enactments. And all congressional and legislative enactments should be along the line of least resistance, to the end of holding everybody to equal, but not always identical responsibility.

The Supreme Court of the United States, in the Carmack Amendment Case, No. 215, October Term, 1910, Atlantic Coast Line Railroad Company vs. Riverside Mills, held that:

"It is obvious, from the many decisions of this Court, that

there is no such thing as absolute freedom of contract. Contracts which contravene public policy cannot be lawfully made at all, and the power to make contracts may in all cases be regulated as to form, evidence, and validity as to third persons. The power of the government extends to the denial of liberty of contract to the extent of forbidding or regulating every contract which is reasonably calculated to injuriously affect the public interests."

It is a mistake to imagine that the railroad and its patrons are alone in interest in the transportation obligation. The railroads and their patrons are in error when they assume to make special agreements which contravene public policy. There is an old saying, that of "hewing to the line, let the chips fall where they may." That might have been a good doctrine in the old days, but in these days it depends upon whom the chips fall. It is all right between two of the interested parties, but how about the third? And it is my thought that, as the Interstate Commerce Commission is in authority by virtue of the Interstate Commerce Law, and as the intent of the law is to the end of such investigations that a determination may be made as to mutual responsibility, that is one of the burning questions of the present time which should be investigated to the end that the country generally should understand that the railroads have not the authority or the power to introduce necessary rules and regulations to free the movement of the car, and that, as the railroads are being regulated to the end of improved car movement, their patrons should be treated in exactly the same manner as the railroads, to the end of such necessary rules and regulations that both may serve the general public properly.

I don't know whether I am old-fashioned enough, or new-fashioned enough to believe that a railroad in these days can only be benefited by the exploitation of the business of the community which it serves. In other words, that the main object of the railroad today is to so perform service that the public can increase its tonnage output, so that the railroads will have additional tonnage to handle. And, looking over the past, I find that in the early days of railroading, when the railroad transported a car from station A to station B, if the lading was not immediately unloaded from the car by the consignee, the railroad

unloaded the lading on the ground and threw a tarpaulin over it and took the car for the service for which it was built.

That was the old Drayage or Cartage law. The contract was clean-cut. The railroad was protected in confining itself to transportation. Later, for reasons best known to the railroad officials of 30 or 40 years ago, special privileges were granted to consignees, and among the special privileges it was conceded that the consignee could hold the car for his convenient unloading, and that resulted in special switching, and finally in an exhibit of delayed car movement and congested terminals. In 1888, the conditions were so disastrous to everybody that the railroads, in fear and trembling, introduced car service rules (now know as demurrage rules). But the rules are limited in their scope, and can only partially cure the present evils.

Taking it by and large, a survey of the present situation is encouraging, because, during the past ten years there has been a gradual improvement in the understanding of the patrons of the railroads of their own necessities for service, together with a gradual understanding that the service to them individually is dependent upon their organization to the end of their immediate receipt of cars, and the unloading of their cars within a reasonable time.

The Interstate Commerce Commission is gradually attaining to an understanding of some of the terminal evils, and I am encouraged to believe that, in accord with the understanding of the Interstate Commerce Commission, the railroads, their patrons and the general public, many of the present evils will be eradicated, and the vehicle for service on a railroad will be used in service, and not for storage. Because the railroad car is as well a warehouse on wheels when standing on the tracks of the railroad because the railroad is unable to make delivery, as it is a warehouse when standing on the tracks of the consignee for unloading. When the sitution is thoroughly understood, it will be demonstrated that there is a decreased expense to the consignee when cars are promptly unloaded because of the regularity of service; and that decrease in expenses will be exhibited in the charge per ton for loading and unloading, in discounts, and in stock on hand. The expense of transportation is not confined to the freight, or switching, or demurrage charges. It must be considered in accord with the payments made for transportation,

and delay in transportation which results in an increase in fixed charges account for the conducting of any business.

The practice of reconsigning, distributing and billing of cars for a market are present necessities in order to properly conduct the business of the country, but the time allowances and the privileges should be in accord with the needs of business. The great difficulty in administration is in determining the line of demarcation—in determining what should be allowed, and what is an unnecessary allowance.

It must be conceded that everybody in interest must be supervised. That it is not only the railroads which must be controlled, but it is the railroads' patrons, and the control over the railroads and their patrons must always be considered in the interest of the third party. Therefore, it is not only necessary to consider the law as it must be applied, but equity practice should be established. And additionally, every rule and regulation that applies to transportation should be considered in relationship to expediency. Something cannot be done in no time. The necessary time should be provided for. Additionally, supplementary service can never be performed at no expense. The law says that nothing can be done in no time; that no conveyance of property rights can be made without an equivalent. And the courts have invariably maintained, in giving consideration to transportation obligations, that individual convenience is subservient to the public good.

The present demurrage rules, with the exception of the average rule, are practically a comprehensive digest of the obligation of the railroads and their patrons, as far as they go. They give consideration to the literal letter of the law, and it is true that they give consideration where consideration is not always warranted. But, the framers of the rules fail in an appreciation of the fact that, as the demurrage charge is in the nature of a penalty for breach of contract, it partakes of the nature of a police law, and, consequently, consideration should be given to mitigating circumstances under untoward conditions.

In regard to the average rule, I have always maintained that it is a step backward. That it is a rule that can be, and is used to the end of unnecessary detention to certain specified cars, that detention being entirely within the control of the consignee

or consignor. Under the average rule, car efficiency is not maintained, and cars are abused by certain patrons of the railroads in their service, without compensation. The average rule is a special contract, and is in contravention to the decision of the Supreme Court of the United States, as rendered by said court in Opinion 215, in relation to the Carmack Amendment.

To summarize: All bars to service at terminals should be removed by comprehensive rules and regulations pertaining to interchange of cars between railroads. All bars to service should be removed by comprehensive rules governing delivery to, and receipt of cars from consignees and consignors. All bars to service should be removed by necessary changes in the present laws which will allow the railroads to re-take their cars for the use of their patrons generally when consignees refuse to receive a car, and consignor unnecessarily defers furnishing disposition. All bars should be removed in the movement of cars specially used in the handling of perishable freights by the passage of necessary laws relieving the railroads of the necessity for holding perishable freights until the value of the lading has materially decreased.

Burdensome rules and regulations mitigate against the common interest in proportion to the volume of the business handled, and as the volume of the business of the railroads is increasing, present abuses will increase unless a remedy is applied. The underlying laws—the laws of merchants—the laws that obtain in the transaction of commercial business, should as well obtain in the regulation of the railroads, and should as well be recognized to the end of proper regulation of the railroads, as they are recognized in the ordinary business transaction between individual citizens.

TONNAGE OF PITTSBURGH DISTRICT

Year.	Railroad.	River.	Total
1897	36,679,415	7,318,366	43,997,781
1898	39,387,925	7,407,243	46,795,168
1899	49,475,211	9,181,486	58,656,697
1900	57,005,465	8,813,166	65,818,631
1901	64,125,000	9,100,000	73,225,000
1902	78,950,000	10,900,000	89,850,000
1903	79,750,000	10,673,394	90,423,394
1904	77,750,000	8,209,356	85,959,356

Year.	Railroad.	River.	Total
1905	92,000,000	11,023,928	103,023,928
1906	113,000,000	9,000,000	122,000,000
1907	146,798,351	14,395,816	161,194,167
1908	104,500,508	11,454,895	115,955,403
1909	145,580,388	12,426,154	158,006,542
1910	156,301,531	11,431,737	167,733,268
1911	152,073,897	12,519,776	164,593,673

The tonnage figures for 1912 have not yet been compiled, but from reports received it will be equal to, if not greater, than 1910 tonnage.

(Statement furnished by Ira S. Bassett, Traffic Manager, Pittsburgh Chamber of Commerce, January 20th, 1913.)

PRESIDENT: Gentlemen, when I read the advance copy of this paper, I put down in writing what I considered the underlying principles therein and I will read them:

First: Terminal organization, with proper records, are essential to efficient service.

Second:—Improved service can be had by the practical application of present demurrage and per diem rules.

Third:—Detentions to cars by reason of delays in unloading cause irregular service and impaired car efficiency.

Fourth:—Persons responsible for delays in releasing cars share with the Railroad Companies the responsibility for car shortage.

As you discuss this question I would be glad if you would touch upon these points.

I think it would be of interest to the Club to have me first call upon the Superintendent of the "model" railroad of which we have heard tonight, and I will therefore call upon Mr. F. R. McFeatters.

MR. F. R. McFEATTERS: Mr. President and Gentlemen —I do not know that the Union Railroad deserves as much credit as Mr. Prall gave us for good work. We are geographically situated so that we can get records I think as nearly correct as it is possible to get them. We are certainly in a better position for per diem service and car records than they are in Chicago, if Mr. Prall is telling us the truth about conditions there.

We think the car service has benefited us, and I have had

some notes made showing where we think it is of advantage to us.

(1) By all concerned in the handling of cars realizing their interdependent responsibility, the delay to the individual car has been materially reduced, also the average detention to cars as a whole has diminished.

(2) Yard switching has somewhat diminished.

(3) By having an independent organization which controls all reports from yard clerks and yard masters relative to demurrage, all responsibility is removed from the Superintendent and we are able to get reports within a fraction of a per cent of being perfect.

(4) By working the per diem and car record department in close harmony with the demurrage department we are able to close practically all open records and pay car owners all per diem due them in the current month. Handling an average of 100,000 cars per month, our open records in the car record department at the end of the month average about 40 cars. About 90% of these can be adjusted in time to make settlement in the report for the following month. The following report will bear out this statement:

June, 1912, we handled 17,681 B. & L. E. cars, paying car owners in the current month $22,195.20, in subsequent months $25.80 by claim.

April, 1912, 13,134 P. R. R. cars, $12,882.10 per diem paid in current month, $2.40 paid on claims.

April, 1912, 2,753 P. & L. E. cars, $1,673.70 per diem paid in current month, $1.20 paid on claims.

April, 1912, 3,985 B. & O. cars, $4,389.20 per diem paid in current month, nothing paid by claim.

To substantiate the correctness of our demurrage records would advise that for a period of two years we assessed $2,518.00 demurrage against miscellaneous shippers and consignees under the straight rule, and of this amount we cancelled only $31.00 on account of error in record.

PRESIDENT: Is Mr. Hoffman, Superintendent of Car Service of the Pittsburgh & Lake Erie Railroad, here? If not, is there any one here who will speak for the P. & L. E. on this subject? Mr. Wendt?

MR. EDWIN F. WENDT: I do not speak for the Car

Service Department of the P. & L. E. R. R., and the remarks which I make will be along general lines.

The paper of the evening admits of very extended discussion, but time will permit of reference only to a few points. Primarily, a railroad is a manufacturing plant. It has a single object, namely, the safe, economical and expeditious movement of traffic. Now you will notice that the primary object of the railroad is the *movement* of traffic. The object is not the *safe housing* of traffic or the *economical housing* of traffic in *warehouses;* but the sole object of the railroad as a manufacturing plant is to move traffic safely, economically and expeditiously.

The terminal is one of the important elements of the railroad, and terminal expenses, under present day traffic, is very large in proportion to the whole expense. In order to operate a terminal as Mr. Prall would like to see it operated, it is necessary first to produce a terminal which can be operated as he desires. There are three steps in the design of every terminal. First, somebody must dream out what the terminal ought to be. This is called the conception of the terminal. Secondly, somebody must put down on a plan the design of the terminal which has been dreamed out by the one who conceives it. And in the third place, the terminal must be constructed. After it is constructed it must be operated strictly in accordance with the design (if the design is based on correct principles), and unless it is operated in accordance with the principles which underly the design, the economy of movement will not be effected.

It is therefore necessary to find some way by which terminals of proper design can be produced. This is difficult because in many instances the location and shape of the particular real estate which must be used does not lend itself to a proper design. Terminals quite generally, I think, of America have just grown up, like Topsy grew up. One facility was added to another. The business increased so rapidly that it was impossible at the start to see the end, and therefore the design as originally prepared did not meet the necessities of the development which forced itself in subsequent years. I am a great believer in thinking out a problem before actually putting money into construction, and in order to think out a problem one has to get down to the basic principles which should govern. Mr. Prall has mentioned a great deal in respect to the difficulties which are ex-

perienced by agents and yard masters and shippers and consignors, and every one of those difficulties, when properly understood, can be eliminated by the execution of a design which is thoughtfully and carefully worked out.

Now, with respect to this idea of a separate terminal organization, I am not prepared to speak. The idea looks good and I believe it would result in the more expeditious movement of the traffic.

One more point. Terminals are very expensive, much more expensive that the greater portion of the people realize. In order to get the terminals which are demanded on all sides, in order to produce the terminals which will do the work which ought to be done under the principles laid down by Mr. Prall, a large amount of money will be required. How to get this money is a great problem, because of the relations of the expenses of a railroad in this present year to the gross earnings. I want to call your attention to three very important points with regard to this matter of the relation of expense to gross earnings.

In 1890 wages consumed 37.71% of gross earnings, while in 1911 wages consumed 41.90% of gross earnings.

In 1890 dividends consumed 28.37% of gross; in 1911 dividends consumed 24.27% of gross earnings.

In 1890 the ton-mile rate paid by the shipper was 9.3 mills; while in 1911 the ton-mile rate in America paid by the shipper was 7.5 mills.

Now, in order to condense these figures, I will state the facts this way: From 1890 to 1911 the rate of return received by the railroads declined from 9.3 mills to 7.5 mills. There was a steady decline for the 21 years given in the statement. During this same time there was a steady decline in dividends, from 28.37% to 24.27% of gross earnings. In other words, capital invested in railroads is steadily receiving less and less year after year. Wages increased from 37.71% to 41.90% of gross earnings.

The salient point in this statement is the fact that the railroads are receiving less and less year after year for the service which is performed, while the cost of performing the service is going up. This has a very vital relation to the raising of capital to build such terminals as are demanded to fulfill the obliga-

tions of a railroad in accordance with the basic principles laid down in the paper of the evening.

PRESIDENT: I will now call upon Mr. J. F. Chalfant, Chief Clerk of the Accounting Department, P. R. R., to speak for the P. R. R.

MR. J. F. CHALFANT: Mr. President and Gentlemen—It was only this afternoon that I received a copy of Mr. Prall's paper, and consequently I did not come here thoroughly equipped to engage in a very general discussion. In listening to Mr. Prall's remarks and the reading of his paper, however, I gained the impression that the gist of it aimed particularly at supervision, and I can discuss that feature of it only from the standpoint of a demurrage man.

Without casting any reflection upon the demurrage bureaus of the past, which have been abolished, the thing that impressed me most when the supervision of demurrage fell practically upon my shoulders was the fact that in the past the records had not been thoroughly audited. This was so shown by the fact that when the reports came to us it was impossible to audit 50% of them—and I do not think I am overstating the number when I make that assertion. It was necessary to send them back to the agents and ask them to give us the information which would enable us to determine, for instance, what the free time was, when the free time began, and whether demurrage earnings had been properly extended.

Mr. Prall has properly stated that the demurrage rules are law, and in that connection I would like to point out that if there is not proper supervision in carrying out that law, it must certainly result in discrimination in cases where the law is strictly enforced. That is a very vital point—proper supervision to see that the rules are enforced, which may result in the expenditure of money to get the records necessary to enforce the rules.

There is nothing in Mr. Prall's remarks, I think, in which I do not entirely agree. As far as the average rule is concerned, I have always felt that an average rule was a good rule for the shipper who desired to hold cars, but a mighty poor rule for the railroads. And in making that statement I might add that the present average rule on the basis of debits and credits, instead of the previous average rule on the basis of hours, was intro-

duced by myself,—first in the territory of the New York and New Jersey Car Demurrage Bureau, whence it spread to four other car demurrage bureaus, continuing until the National Association of Railway Commissioners took up the matter of uniform rules and handed us a code of demurrage rules on a platter, which code included an average rule on the basis of debit and credit days.

As to Mr. Prall's remarks regarding the making of proper laws to enforce the unloading of cars, I might say, as a matter of information to those who are not already aware of the fact, that a bill has been introduced in Congress by Representative Prouty which compels carriers to unload a car in order to put it into service if the consignee fails to unload within five days; also to unload a car that has been loaded by a shipper if he fails to give shipping instructions within five days. It also carries with it a reciprocal demurrage feature, the carrier being liable to the shipper for all actual damage sustained for failure to furnish a car for a shipment within five days, and, in addition, a charge of $5.00 a day for each day beyond the five days; provided, however, that the carrier has not complied with the provisions of the law or fulfilled the law as intended by the bill; that is, has not unloaded cars where the shipper or consignee has failed to bill forward or unload within five days.

I think, Mr. President, that is about all I have to say on the subject, and thank you for the opportunity.

PRESIDENT: Is there a member present from the B. & O. who will speak for that Company. I have Mr. Angell's name. Possibly he will speak.

MR. C. P. ANGELL: I would like to be excused.

PRESIDENT: Mr. Deneke, Agent, B. & O. R. R.

MR. W. F. DENEKE: I did not come prepared to discuss this question. This is the first opportunity I have had of seeing Mr. Prall's paper, and there is nothing which I could suggest that would improve on the present rule; therefore I am not in a position to criticise it. Mr. Prall is the father of the present rule and I am very glad to have heard his address this evening. I am sorry I am not in a position to discuss the question as freely as I should like.

PRESIDENT: I notice Mr. Sheets, of the Montour Railroad. May we hear from him?

MR. H. E. SHEETS: This is entirely unexpected, I am sure. It is the first night I have been here for quite a number of years. I have not made a study of this subject and I do not know that I could present anything that would be of benefit.

PRESIDENT: I will call upon Mr. Bihler, Traffic Manager of the Carnegie Steel Company, who is always ready to talk to us.

MR. L. C. BIHLER: Mr. President, sometimes I am ready to talk. But on an occasion like this, when Mr. Prall is the orator of the evening, I want to confess right at the start that I am dazed and unable to talk. If I know anything about car service, it is because Mr. Prall has been my schoolmaster and with many a "blow" he has pounded it into my hide.

After listening to him, I think you will agree with me that he is a sort of human encyclopedia of information and ideas on the subject of car service, per diem and terminal service.

There are only one or two points that I would like to mention briefly. To take the heads suggested by our President:

1. "Terminal organization with proper records are essential to efficient service." I do not believe there is much argument on that question. Where the organization does not exist, you do not get efficiency, and where you do not have it, you ought to have it.

2. "Improved service can be had by the practical application of present demurrage and per diem rules." Correct also. You have got to have system and run it through right. I do not want to refer to the "model road," because enough has been said on that subject. Besides, I am not an officer of the road. They have got to carry their own troubles.

3. "Detentions to cars by reason of delays in unloading cause irregular service and impaired car efficiency." I can subscribe to that, because I have been through the mill for a good many years.

4. "Persons responsible for delays in releasing cars share with the railroad companies the responsibility for car shortage." Amen.

There is one point here that I want to refer to in Mr.

Prall's paper, on page 8, referring to consignees. "They must improve the conditions surrounding their sidings; that a business that increases its output 20, 40, 50 or 100 per cent. without an increase in the facilities for loading and unloading, is adding a burden to service." That is correct, and it might be made the subject of a long talk on how some people do not, when they build a new plant or add to an existing plant, tell the railroads anything about it. There are a few railroads throughout the United States that will not give a man a siding until he shows them the capacity of his plant and his sidings and the shipments which he expects the railroads to handle for him, and then they both plan together and work out the best way, and then that is in the nature of a private terminal.

When it comes to increasing general terminals, if the men will get on the job and find out what is being done in the way of additions and improvements and new plants, they can better see what is up to the railroads to provide for in the general terminal.

I think that is about all I have to say.

PRESIDENT: I notice among those present Mr. E. E. Zeigler, who was for many years Agent of the Pittsburgh-Duquesne. Can we hear from him?

MR. E. E. ZEIGLER: Mr. President, I had not expected to be called on. I hardly know where to begin, but I just care to say this: I see so many young men that I am highly conscious of the fact that I am the oldest man in the room and have been lined up with the has-beens. Many of you will want to know how I put in the time. A gentleman said to me a few days ago, a farmer down the Ohio Valley who, having reached a reasonable age and accumulated a very modest sum of money —which I have not—sold his farm, and assuming that he had a modest competency, was moving around in the country as he pleased. A gentleman said to him: "Mr. Wilson, you seem to be most vigorous and all that. How do you put in your time?" "Well, sir, I will just tell you how it is. I just set and think— and sometimes I just set."

I have just been sitting and listening, and inasmuch as anything I might say would not improve the car service rules, and any criticism of the present rules would not be proper coming from me, I will tell you an incident of the long ago. I have

known Mr. Prall for perhaps twenty years or near it, and the first time I met him was at Milwaukee at a Freight Agents' Association meeting. Being something of a lady's man, I did not attend the meeting, but went out in the boat and danced with the ladies and put in the day. When I returned to the hotel where the meeting was being held, not unlike this, I was met by an old agent of the B. & O. Railroad calling "Peebles, Peebles!" I thought, "Goodness me, what is the matter? Has the roof fallen in?" I said "What has happened?" Why they were discussing the car demurrage rules, and Peebles said: "Down in Pittsburgh we collect from the little people and the big people don't pay anything." "Well," I said, "you get that corrected." The next day when the matter was called up we eliminated that from the minutes and straightened it out, and I thought that was the end of it. And we had a jolly good time, because Milwaukee is a good town to have a good time in. I returned to Pittsburgh, and forty-eight hours afterwards a gentleman, who like myself has passed the active list, and who has passed away now, known as R. P., sent for me. You all know how happy you feel when you are brought into your superior's office and he gives you a cigar and entertains you nicely a moment or two and then hits you like this: "Were you all drunk at Milwaukee?" "I said: "I was not. I am a Methodist." "Was Peebles drunk?" "I can't tell you that. Like yourself, he is a Presbyterian elder and you will have to answer for that. "But," I said seriously, "Mr. Pitcairn, we eliminated that objectionable feature from the minutes." "Yes," he said, "You told the truth the first day and lied the second."

I will not follow that line of thought any farther. It is no care of mine. However, just let me say now that I am here at the invitation of, I hardly know whom. However, I am pleased to be here, and I want to repeat what I believe no agent in this territory will raise objection to, that no man in all this country has contributed more to put the car service rules on a working basis that Mr. Prall.

PRESIDENT: Gentlemen, the subject is now open for general discussion or any questions you may wish to ask. We will be glad to hear from any one.

MR. H. M. HIPPLE: Mr. President, I believe we are all agreed tonight that terminal facilities and terminal conditions

are not ideal. There is, however, to my mind a very important factor which has not been emphasized as strongly as it should, and that is this: There is no one factor which militates so much against the maximum terminal and maximum car efficiency as the abuse and misuse of these facilities, and of the equipment. In some cases it may be lack of co-operation, but whether it is abuse, misuse, or lack of co-operation, the result is the same.

If I may take the time, I should like to give an illustration of this: During the month of March, 1911, with normal conditions obtaining on the lines of the Pennsylvania Railroad, we had a daily average of 132,000 railroad cars on the lines. The total freight car mileage in March, 1911, was 115,000,000 miles in round figures. No unusual conditions obtained and the cars made an average of something like twenty-four miles per car per day.

In March, 1912, with an anticipated coal strike hanging over the country, when all concerns were anxious to get a stock of coal on hand and the mines were anxious to get cars, we had an average of only 120,000 railroad cars on the Lines East of Pittsburgh, a loss of 12,000 cars. These 120,000 cars were decreased by 8,000 cars standing under load, held for delivery into New England and Canada, on account of connecting lines being unable to accept, due to continued severe weather conditions.

This practically reduced the available railroad cars to an average of 112,000 cars in March, 1912, as opposed to 132,000 cars in March, 1911, a loss of 20,000 cars, and yet in March, 1912, we made a total of 134,000,000 miles, or practically 18,000,000 miles more than during March, 1911, and this was accomplished simply because instead of holding an average of 50,000 cars loaded with coal at the eastern terminals (I do not mean, of course, that that amount was held on the Pennsylvania Railroad), cars were released and the railroads were able to get them back to the mines promptly—the mines being anxious to get out as much coal as possible, did not hold the cars there unduly, but gave them prompt loading.

All of this goes to show that if shippers and consignees would recognize cars as vehicles of transportation, rather than storage facilities, lending their co-operation to the railroads to the end that the maximum efficiency be secured from both the terminal facilities and the equipment, notwithstanding the fact

that our terminal conditions are not ideal, it will be found that they are adequate not only for the present needs but to take care of the needs for some time to come.

PRESIDENT: Will any one else add a word? If not, do you wish, Mr. Prall, to say anything in conclusion?

MR. PRALL: I am rather inclined to think that the gentlemen have listened to me about as long as they desire to, and I am simply going to refer to the statement made by Mr. Hipple. I was at Indianapolis at the meeting of the Indiana Hard Wood Lumber Association. A representative of the Indiana Commission addressed them. And he took up the question of car supply and stated the absolute necessity for additional cars, and that it was a possibility that laws would be passed holding railroads as responsible unless they so equipped themselves that cars could be furnished upon demand. I took exception to that statement, and I want to make the same statement here that I made there, that is, that it is the obligation of the railroad to give reasonable service and provide itself with reasonable equipment. But no law could ever be passed that would hold a railroad to absolute responsibility for furnishing a car when they did not have the cars for sale for service, if their record showed that if they could maintain their own equipment on their own rails it could be demonstrated that that equipment would serve the interests of their patrons. And I want you to bear that in mind.

Again referring to the statement of Mr. Chalfant that a law is proposed holding a railroad to the impossible, all the railroad has for sale is the empty car, and I will assure you, gentlemen, that there is nothing that will please the Pennsylvania Railroad and the Pennsylvania Lines like having cars unloaded within the physical time necessary for their unloading after the contract obligation is completed, and I will assure you that neither the Pennsylvania Railroad nor the Pennsylvania Company will ever pay one dollar fine if our patrons will co-operate with us along reasonable and interdependent lines of responsibility.

MR. McFEATTERS: I move that we extend to Mr. Prall a vote of thanks in appreciation of a very interesting paper tonight.

The motion was seconded and carried by unanimous vote.

PRESIDENT: Mr. Prall, please accept the thanks of the Club for your excellent paper tonight.

MR. PRALL: I thank you, gentlemen.

PRESIDENT: If there is no further business a motion to adjourn will be in order.

ON MOTION, Adjourned at 10:25.

J. B. Anderson
Secretary.


PENNSYLVANIA


CB&Q

OFFICIAL PROCEEDINGS

RAILWAY CLUB OF PITTSBURGH

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THE MAINTENANCE AND OPERATION OF SUPERHEATER LOCOMOTIVES

BY GILBERT E. RYDER, SALES ENGINEER
LOCOMOTIVE SUPERHEATER CO., NEW YORK

x

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OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, FEBRUARY 28th, 1913.

The regular monthly meeting was called to order by the President, Mr. A. G. Mitchell, at the Monongahela House at 8 o'clock P. M.

The following persons registered:

MEMBERS.

Adams, Lewis
Anderson, H. S.
Anderson, J. B.
Angell, C. P.
Amsbary, D. H.
Ashcroft, C. D.
Ashley, F. B.
Babcock, F. H.
Barron, E. T.
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Blackall, R. H.
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Booth, J. K.
Brandt, E. K.
Brooks, W. A.
Brown, L. M.
Bugle, Geo.
Burry, V. J.
Carpenter, H. L.
Cassiday, C. R.
Cline, W. A.
Code, J. G.
Cole, Jewett
Cotton, A. C.
Courtney, D. C.
Crouch, A. W.
Danforth, G. H.
DeLaney, V. W.
Detwiler, U. G.
Drake, W. C.
Falkenstein, W. H.
Ferguson, D. E.
Fitzgerald, D. W.
Flaherty, P. J.
Gallinger, G. A.
Geddes, J. R.
Gies, Geo. E.
Gillespie, W. J.
Gowdy, H. K.
Grewe, H. F.
Guay, J. W.
Gulick, H.
Hair, H. J.
Haring, E.
Harner, A. J.
Haynes, J. E.
Herrold, A. E.
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Howe, H.
Howe, D. M.
Hudson, W. L.
Hughes, J. E.
Ingold, C. F.
Jones, W. A.
Kelly, H. B.
Kendrick, J. P.
Kinch, L. E.
Kinter, D. H.
Knight, E. A.
Lang, W. C.
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Long, R. M.
Low, J. R.
Lyle, D. O.
Macfarlane, W. E.
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McConnell, P. L.
McIntyre, G. L.
McKenna, J. W.

McNulty, F. M.
McWilliams, J. B.
Neal, J. T.
Newbury, E. H.
Newman, J. F.
Orner, M. T. S.
Partridge, F. G.
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Ransley, F. E.
Redding, D. J.
Reid, D. K.
Rice, D. S.
Richardson, E. F.
Richardson, W. P.
Richers, G. J.
Robbins, F. S.
Runser, K. W.
Ryan, Wm. F.
Ryman, Frank
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Schultz, G. H.
Scott, W. M.
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Stark, F. H.
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Stucki, A.
Sullivan, W. H.
Swope, B. M.
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Tamkins, B. L.
Thompson, C. H.
Thurlby, A. R.
Tucker, J. L.
Walther, G. C.
Walter, W. A.
Way, L. A.
Wendt, E. F.
White, F. L.
Williams, W. W.
Williams, R. F.
Wood, R. C.
Wyke, J. W.
Zinsmaster, F.

VISITORS.

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Baker, C. H.
Bannen, W. J.
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Bingham, John
Bird, Frank
Breese, E. W.
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Noah, W. J.
Nutting, S. D.
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Petty, H. W.
Riddle, F. L.
Robinson, Robt.
Ryder, Gilbert E.
Ryde, H. H.
Sawyer, E. C.
Seitzel, F. O.
Shelton, Jas. T.
Sherman, J. K.

Showalter, A. E.	Stewart, E. C.
Sizer, C. A.	Tilson, R. P.
Smead, D. N.	VanDewall, L. J.
Smith, F. B.	Wassalle, H.
Sneck, Harry	Watrous, H. C.
Speed, C. M.	Williams, J. H.
Spellen, Jas.	Wilson, H. H.
Sproul, H. V.	Wittig, Wm.

Yawman, C. A.

PRESIDENT: The roll call will be dispensed with, as we have the record by cards of the attendance. The minutes of the January meeting having been published, we will eliminate the reading of the same.

The next will be the announcement of new members.

SECRETARY: Mr. President, we have the following applications for membership:

Averell, W. H., Asst. General Superintendent, B. & O. R. R., Pittsburgh, Pa. Recommended by E. J. Searles.

Brown, J. F., Rep. Fairbanks Co., Twenty-ninth St. and Liberty Ave., Pittsburgh, Pa. Recommended by A. W. Crouch.

Breese, E. B., Car Lighting Foreman, Penna. Lines West, 1741 Buena Vista St., N. S., Pittsburgh, Pa. Recommended by Geo. E. Gies.

Buckbee, W. A., Rep. Locomotive Superheater Co., 30 Church St., New York, N. Y. Recommended by J. B. Anderson.

Buckley, Wm., Welding Engineer, Davis-Bournonville Co., 90 West St., New York, N. Y. Recommended by B. Kopfershmidt.

Chester, Chas. J., General Stay Bolt Inspector, P. R. R., Pittsburgh, Pa. Recommended by J. B. Anderson.

Christy, O. B., Assistant Road Foreman Engines, B. & L. E. R. R., Columbia Ave., Greenville, Pa. Recommended byE. F. Richardson.

Cooper, F. E., Foreman, Machine Shop, P. & L. E. R. R., 408 Mill St., Coraopolis, Pa. Recommended by D. J. Redding.

Dalton, C. R., Motive Power Inspector, P. R. R., 612 Industry St., Pittsburgh, Pa. Recommended by J. B. Anderson.

Funk, Sterling R., Rep., Jenkins Bros., 701 Peoples Bank Bldg., Pittsburgh, Pa. Recommended by J. D. Conway.

Haselett, D. H., Asst. Shop Clerk, P. R. R., Liberty Ave. and Twenty-eighth St., Pittsburgh, Pa. Recommended by W. E. Rabold.

Hollett, Grant T., Chief Engineer, B. & O. R. R., Glenwood, Pittsburgh, Pa. Recommended by L. Finegan.

Hood, Chas. F., President, Indian Creek Valley Ry. Co., Connellsville, Pa. Recommended by Reah F. Wilson.

Hood, S. F., General Manager, Indian Creek Valley Ry. Co., Connellsville, Pa. Recommended by Reah F. Wilson.

Keenan, Chas. R., Clerk, Penna. Lines West, Oakdale, Pa. Recommended by M. T. S. Orner.

Lemley, J. S., Supervisor Loco. Operation, B. & O.-C. H. & D. R. R., Grand Central Sta., Cincinnati, O. Recommended by A. W. Crouch.

McAlpin, J. H., Chief Clerk and Paymaster, Carnegie Steel Co.,. Pittock, Pa. Recommended by Harry Howe.

Peach, J. F., Chief Clerk to Supt. M. P., B. & O. R. R., 1008 House Bldg., Pittsburgh, Pa. Recommended by E. J. Searles.

Ryder, Gilbert E., Sales Engineer, Locomotive Superheater Co., 30 Church St., New York, N. Y. Recommended by J. B. Anderson.

Sawyer, E. C., Salesman, H. G. Hammett Co., 305 Botetourt Apts., Norfolk, Va. Recommended by E. J. Searies.

Sherman, J. K., Asst. Div. Engineer, Penna. Lines West, 1013 Penn Ave., Pittsburgh, Pa. Recommended by D. O. Lyle.

Waugh, John T., Chief Clerk, Atlantic Coast Despatch, 839 Oliver Bldg., Pittsburgh, Pa. Recommended by M. T. S. Orner.

Wenrich, M. L., Asst. Road Foreman Engines, P. R. R., 2421 Beale Ave., Altoona, Pa. Recommended by S. G. Glassburn.

Wittig, William, Foreman, Boiler Makers, American Loco. Co., 1227 Woodland Ave., N. S., Pittsburgh, Pa. Recommended by W. J. Gillespie.

SECRETARY: If these applications are approved by the Executive Committee, they will bring our membership up to 1,030.

PRESIDENT: Those whose names were just read will become members as soon as the Executive Committee passes upon them, without any further action.

There being no reports of Committees or unfinished business to act on, the next in order will be discussion of the subject for the evening. The subject is "The Maintenance and Operation of Superheater Locomotives," and will be presented to you by Mr. Gilbert E. Ryder, Sales Engineer, Locomotive Superheater Co., of New York.

MR. RYDER: Mr. President and members of The Rilway Club of Pittsburgh, the paper which I wish to present for your discussion tonight is "The Maintenance and Operation of Superheater Locomotives."

THE MAINTENANCE AND OPERATION OF SUPERHEATER LOCOMOTIVES.

BY GILBERT E. RYDER,

Sales Engineer, Locomotive Superheater Company.

The presence of moisture or condensation in the cylinders of all types of engines using saturated steam, has been recognized, since the early days of steam engineering, as constituting the greatest loss attending their operation. While it has been known that this loss could have been greatly reduced, and completely avoided, as later experience has shown, by the use of superheated steam, it is only within the past few years that its use has come to be adopted generally. Attempts were made to employ superheated steam in the operation of steam engines as early as the year 1830, and careful experiments were made again some twenty years later. These experiments were all carried on with a view of using low or moderate degrees of super-

heat. The results showed that it was possible, by this means, only to slightly reduce the condensation. The lack of a proper lubricant to resist the temperatures of steam with higher degree of superheat, together with the introduction of the practice of compounding and the employment of relatively high steam pressures, resulted in the abandonment of experiments with superheated steam at that time.

About twenty years ago Doctor Schmidt began experiments with a superheater furnishing steam with a high degree of superheat. The results of these experiments proved so successful that about five years later the superheater became practically established as part of the equipment for locomotives on the Prussian State Railways, where the trials were made. From that time to the present over twelve thousand superheaters have been applied to locomotives on European railroads, and it is an interesting fact, in connection with this rapid advance in the adoption of superheaters on European roads to note that the general principles of the design remain very nearly the same as the first superheaters built.

While superheating became popular in Europe fifteen years ago, it was not adopted generally in this country until about three years ago. Its success, however, became established in America at the time when need was most felt for some means of increasing the efficiency of the locomotive. It was at a time when there was considerable legislation adverse to railroads on the one hand and rapidly increasing cost of operation on the other, resulting in the reduction of the net earnings of the railroads and making economy emphatically necessary. That the superheater met the emergency is a matter of record and that the records were satisfactory is established by the extent of its adoption. In this period of about three years there have been approximately seven thousand superheaters applied to locomotives on American railroads.

CONSTRUCTION AND ECONOMY.

The construction of the Schmidt superheater, which has come to be recognized as the standard used by practically all railroads in this country, is no doubt familiar to most railroad men. The principle followed in the design of this superheater is that of the disposition of coils or units in the large boiler flues. The forward ends of these units are connected with a

receiver or collector casting, known as the header, which takes the place of the ordinary tee head in saturated steam practice and like the tee head is located in the upper part of the smokebox. The superheater units consist of four $1\frac{1}{2}''$ outside diameter cold drawn seamless steel tubing, connected together by cast steel return bends, extending to within two feet of the firebox tube sheets. In their location in the large flues they are exposed to the temperature of the gases from the firebox, which range from sixteen hundred to six hundred degrees throughout the length of the tube. The steam passing through these pipes, and subjected to this range of temperature is superheated to 200° or 250°. The effect of raising the temperature of the steam to these high temperatures is that of making it capable of passing through the cylinders without condensation. Superheat does not increase the pressure nor raise the mean effective pressure of the steam. While it does temporarily increase the specific volume of the steam about 30% above that of saturated steam at the same pressure, some of this increase in specific volume is lost between the superheater and the point of cutoff. While it may leave the superheater with from 200° to 250° of superheat, it will have left probably about 100° at the point of cutoff. The saving that is obtained results from the entire elimination of all losses through cylinder condensation, together with that obtained by the remaining increased volume of the steam. These savings, under average conditions, amount to approximately 30% in steam or water consumption, which corresponds to the saving in fuel of from 20% to 25% compared with saturated locomotives working under the same conditions. It thereby provides an increased hauling capacity, which, using the coal saving as a basis, amounts to from 30% to 35%.

OPERATION AND MAINTENANCE EXPERIENCE.

While these savings represent what is possible to obtain with the superheater, they depend largely upon proper methods of operation and maintenance. This then brings us to the subjects in which the Mechanical Departments of railroads are most interested, that is, maintenance and operation, for, while we are all more or less interested in the design and construction of the apparatus, this interest on the part of the mechanical railroad men is viewed from the standpoint of simplicity in design to the end that it may be accessible for maintenance and eco-

nomical in operation. While these methods do not differ materially from the proper methods to be followed in the maintenance of saturated steam locomotives, there are some points which require special attention. The importance of giving attention to these special features can only be realized by experience and it is often the case when the first superheaters go in service on railroads that difficulties are encountered, that disappear after they have been in service for some time and the men who care for them at the terminals, as well as the engineers and firemen, become more familiar with their peculiarities.

LEAKS: FRONT FLUE SHEET BALL JOINTS.

In the maintenance of superheater locomotives proper care at the time the locomotives are received has much to do with their successful operation and the amount of attention that must be given them during the rest of the time that they are in service. The principal troubles that are experienced at the outset are leaks in the front flue sheet and leaks in the ball joint connections between the units and the headers. In order to prevent serious trouble resulting from these leaks later on, it is found to be a good practice to test the boiler for leaks in the front flue sheet after the engine has made two or three trips, and at the same time the superheater may be tested for leaks in the ball joint connections. It requires very little time to make these tests and the leaks may be repaired while they are small, before any serious damage is done. Leaks that are discovered in the ball joint connections at this time may, in a great many instances, be stopped by merely tightening the nuts on the unit bolts. It is also a good practice, at this time, to go over all the unit bolts and take up whatever is possible on them, whether any leaks show in the ball joint connections or not. The heating and cooling of the bolts when they are first applied seems often to have a tendency to stretch them and it is often possible to take up a part or even a full turn on the nuts.

The seriousness of leaks in the front flue sheet or in the unit joints can best be illustrated by instances where they have occurred and have been allowed to run without proper attention. One instance recently came to my notice where the front flue sheet had cracked; the steam from the crack impinging on one of the unit pipes had cut a hole ¾″ in diameter in it. The steam from the hole in the unit pipe and from the crack in the

front flue sheet, together with the cinder, completely stopped up several of the large flues with a mass of cinder and scale baked so hard that it was almost impossible to remove the unit. A leak of this kind must have been going on for a considerable length of time in order to have cut so large a hole in the unit pipe and had inspection and tests been made the trouble would have been located and repairs made before it had gone so far, and it would not have been necessary to make such extensive repairs. This instance also illustrates to what extent these conditions may exist and locomotives still not fail entirely for steam.

FLUE SETTING.

The methods of setting superheater flues are practically the same as those followed in the setting of small boiler flues, except that the large flues are beaded in the front flue sheet, as well as in the firebox sheet. In preparing the sheet to receive the large flues the hole should be chamferred in the sheets to remove any burr that may be left by the cutting tool and also to remove the sharp edge, thereby reducing the liability of its cutting into the ferrule of the flue. The use of copper ferrules is, of course, recommended without exception and the ferrule used in connection with superheater flues is somewhat heavier than that used in the ordinary flue.

FLUE MAINTENANCE.

In the maintenance of flues too much emphasis cannot be placed upon the standardization of prossers, rollers and beading tools. Prossers of various contours used in the same flue operate more to its damage than to its good. The contour of the prosser used in the first working of the flues after they have been set, should be maintained throughout the life of the flue. Experience has proven that the prosser with less than twelve sections should not be used. The roller which has given the best service is one with at least five rolls. The three-roll roller similar to the one used in rolling the small boiler tubes, has been found to be too severe on the large flues, on account of the liability of setting the rolls too far into the flue and of rolling up the metal between the rollers. As it becomes necessary to work the flues from time to time, the best results will be obtained if the prosser is given preference and the rollers and beading tools used only when the conditions are such that their use cannot be avoided.

SAFE ENDING.

The large flues are safe ended when safe ending is necessary on the back end or firebox end of the flue. The method of swaging the flues to a standard diameter of $4\frac{1}{2}''$ is done to facilitate the safe ending. The practice of safe ending the back end of the flue makes it necessary to carry but one size of safe ending material in stock and brings the operation of safe ending within the range of many of the flue welding machines now installed in many railroad shops. The swaged portion of the flue being about 6″ long and the distance from this part of the flue to the end of the superheater unit is about 18″ and safe ends should be as short as possible in order to increase the number of safe ends applied before it becomes necessary to re-swage the flue, which will occur when the small part of the flue interferes with the end of the unit. In applying safe ends after the first time, it is advisable to cut off the flue far enough back to remove the old weld, thereby providing that there be only one weld in the flue. The principal reasons for safe ending the back or small end of the flue are, briefly, because it provides material at the firebox end of the flue where the service is most severe. The small or swaged end of the flue being less in diameter the cost of safe ending material is less, and inasmuch as the diameter of the small portion is standard for both the $5\frac{1}{2}''$ and $5\frac{3}{8}''$ flues, it is necessary to carry but one size of safe end material in stock.

FLUE CLEANING.

The flue cleaning question is *always* a vital one whether it be in the saturated steam locomotive or the superheater locomotive, and the superheater often is blamed when a condition of the superheater flues exists which would not be tolerated with the ordinary tubes. The thorough cleaning of boiler tubes is, beyond doubt, of very great importance, for on it depends the primary function of the boiler, namely, the transference of heat from the gases to the water. The medium at best is poor, but when it is allowed to become coated and incrusted with a poor conductor of heat the loss is great.

It is often forgotten, by those who find the flue cleaning a considerable problem, that it was necessary sometimes to clean flues before the advent of the superheater; and that it was often necessary to take flues out of saturated engines because they were stopped so badly that it was impossible to bore them out.

In other words, the flue cleaning problem did not begin with the introduction of the superheater, and stopped-up flues should not be charged entirely to it. It is very nearly always the case, when our traveling engineers report that superheater flues are stopped up, they have found a large percentage of the small tubes in the boiler stopped up as well.

As to the method of cleaning flues, it consists simply of inserting a ⅜" pipe connected to the roundhouse air line into the back end of the flue and blowing the soot out the front end, the pipe being long enough to extend entirely through the flue; the air pressure should be about 100 lbs.

DAMPERS.

There has been considerable controversy recently as to whether the operation of superheater locomotives without dampers would be detrimental. The omission of the damper may not, and probably will not, result in any immediate trouble. Eventually, however, there will be trouble from leaky unit pipes resulting from the action of high temperature that they are exposed to when there is no steam within them to absorb the heat. In other words, the operation of the locomotive without the damper will shorten the life of the superheater units and the trouble may come immediately or it may be after the engine has been in service one or two years. The fact that the omission of the damper will not cause any immediate trouble, makes it impossible to put much faith in the reports that good results are being obtained without dampers until they have been run in this manner throughout the life of the superheater. It will take some time for the trouble to develop and no doubt roads operating extensively without dampers will sooner or later experience trouble from leaks in the unit pipes at points nearest the firebox, where they are subject to the highest temperature.

COST.

From the foregoing it might be inferred that there is considerable increase in the maintenance cost of the superheater over the saturated locomotive. This is not, however, the case. While there are no figures available as to the actual maintenance cost per ton mile, circumstances make it conservative to say that it costs at least no more to maintain a superheater locomotive than it does a like saturated locomotive. One large railroad that

has about 800 superheaters in service finds that it has not been necessary to increase their roundhouse organization at any point on account of additional work necessary to maintain the superheater.

OPERATION.

The main difference in the operation of superheater locomotives compared with that of saturated locomotives lies entirely in the reserve power that the superheater locomotive is capable of developing. It is very difficult for an engineer, who has been operating a saturated locomotive, where it is a continual fight for steam, to realize that with a superheater locomotive it is possible to work the engine lower down or with a longer cut-off without the steam pressure falling back.

It is a fact that the efficiency of the superheater increases as the demand for power increases. This point can be illustrated best by examples that come to our attention every day, showing the possibilities that lie in following proper operation methods.

The fear on the part of engineers to take advantage of the reserve power that is available is illustrated by the following incident: The engineer had been operating a saturated locomotive and having considerable difficulty in getting over the road and maintaining the schedule with seven or eight cars. A superheater locomotive was given him and he was running her practically the same way that he had operated the saturated locomotive. There was one particularly difficult portion of the road where a slow order to ten miles per hour was in force across a long bridge. Directly upon leaving the bridge it was necessary to negotiate a 1% grade. The representative of the Superheater Company was on the locomotive and suggested to the engineer that he work the engine at least half stroke up the grade. After some little persuasion he was prevailed upon to take a chance in spite of his fear that the water would get away from him. It is needless to say that the locomotive pulled nine cars up the 1% grade, accelerated from 10 to 45 miles an hour before the lever was hooked up and without any variation in the steam pressure or any damage by low water except that of wearing out the gauge cocks while watching the water. Another instance that I know of was the Mikado locomotive on a 3/10% grade with an adjusted tonnage of 5,000 tons, which is equivalent to about 4,700 tons actual. When on the grade it was decided to see how

far the lever could be dropped before the engine would fail for steam. It was dropped one notch at a time until it was clear in the corner. One injector was on full and the other injector worked intermittently. The speed was accelerated to 18 or 20 miles an hour and the pressure did not drop below 190 lbs. These two instances illustrate the power that is available with a superheater locomotive, but it must be operated right to get all out of the engine that there is in her.

FIRING.

In the operation of the superheater locomotive it may be said in general that what is good for the saturated locomotive is also good for the superheater locomotive. The fire carried should be level and as even as conditions will permit, firing light and regular and maintaining a bright white fire over the entire box. By following the proper methods of firing, higher temperatures can be maintained in the firebox, which means higher temperatures in the large flues and more superheat. On this subject I wish to quote from a discussion of a paper recently read before a railroad club:

> "When we were making tests for temperatures, I had some particular observations taken of the firing conditions and found very remarkable results. We found that the temperature with the superheated steam was more constant and higher when a light fire was maintained and careful methods of firing were followed as against careless methods. For instance, leaving the door open or firing with a large number of scoops at a time, thus deadening the fire and then permitting it to die down before firing again. We had curves of temperatures that were very irregular."

FULL THROTTLE.

Another point that may be considered in the operation of superheater locomotives is that of running with a full open throttle wherever it is possible. There is always some drop in pressure between the throttle and the cylinders in any locomotive. This drop in the superheater locomotive is very little greater and will be increased still more by any wire drawing through the throttle. The best practice in operating the superheated locomotive is with a full throttle wherever the conditions permit, cutting back the reverse lever or reducing the cut-off if

a reduction in power is required. This practice should be carried on until the point of most economical cut-off is reached, after which further reductions in power should be made by reducing the throttle opening.

HIGH WATER.

Another point that should be given particular attention in the operation of the superheater locomotive is that of carrying the water too high in the boiler, for the efficiency of the superheater may be greatly influenced by the water level. It has been said that the high water man, operating a saturated locomotive, needed a superheater to overcome the bad effects of this practice, and it is a fact that the superheater will help out the high-water man. It will be possible for him to carry water at almost any level without being able to detect its presence in the cylinders.

Records will show, however, that the high-water man is not getting the economy out of the superheater that is available, for the superheater is being used virtually as an auxiliary boiler to evaporate the moisture or water carried over. In other words, the heat that should go toward raising the temperature of the steam is being utilized to evaporate the water and the final temperature of the steam is much below what should be obtained and the efficiency of the superheater greatly impaired. It is not necessary in the operation of the superheater locomotive to carry the water so high as certain conditions in saturated practice demand. The superheater locomotive develops the same power on from 30% to 35% less water, thereby reducing the liability of the water getting away with the same rapidity as it does in the operation of saturated locomotives when it is necessary to trade water for steam.

OIL FOR LUBRICATION.

With reference to the quality of oil used in superheater locomotives, it is only logical that an oil with a flash point higher than that ordinarily used in saturated engines is advisable. The oil that has been used for a good many years in saturated locomotives has a flash point of about 500° and carbonizes at temperatures considerably below 500°. Inasmuch as the temperature of the steam chest and cylinders is at times considerably higher than the flash point of this oil, it is necessary to provide oil with

a higher flash point than that used in saturated practice. In spite of the fact that it has been demonstrated that oil with a flash point of 500° may be raised to temperatures several hundred degrees above this point, while enveloped in steam, without impairing its lubricating qualities, it is not always possible to control this condition and keep the oil surrounded by steam while the parts to be lubricated are at a temperature above its flash point. There are times when the engine is shut off that the temperature of the steam chest and cylinder walls are above the flash point of the oil. Under these conditions the oil must necessarily carbonize and it is in order to meet these conditions and prevent the carbonization that an oil with a flash point approaching the maximum temperature of the cylinder and steam chest walls is recommended. After good material and good workmanship have been provided in the valves, cylinders, bushings and rings, and a good grade of oil has been secured, the proper distribution of this oil remains. This can be best effected by a five-feed lubricator, distributing oil to the steam chest and cylinders of the engine. The engineer can also facilitate the lubrication by slightly cracking the throttle while drifting, thereby keeping steam in the cylinders to protect the oil until the temperature has been reduced below the point where the oil is affected.

PISTON ROD PACKING.

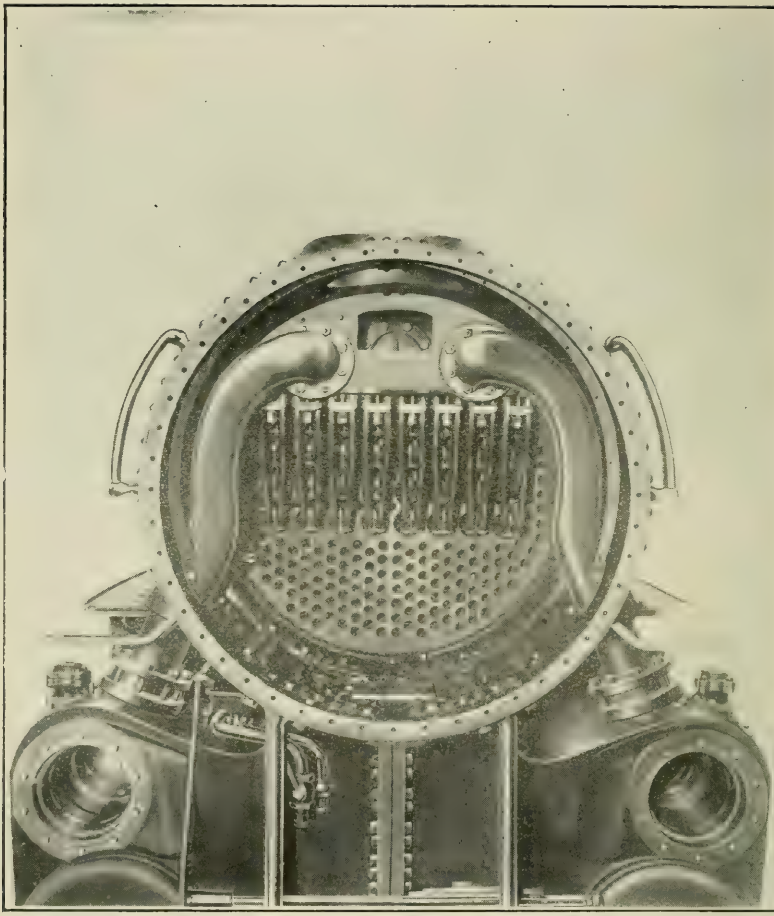
There has been some trouble occasioned by the melting out of piston rod packing. Experiments have been made to meet this condition in which various packing mixtures have been used. The mixture which has given the best results is made up of 80% lead and 20% antimony, which has a melting point well above the temperature of the superheated steam. This mixture, however, is not infallible and there are instances where it has melted out in service. These instances do not point to the fact that the mixture is unsuited to the purpose, because piston rod packing is considered satisfactory in saturated steam practice and occasionally gives trouble by melting out. In the case of the superheater locomotive, as well as the saturated locomotive, the melting out of piston rod packing is not so much due to the high temperature of the steam. It is generally caused by too high temperatures generated by the friction between the packing and the rod, due to improper lubrication. This trouble may be avoid-

ed by correcting the lubrication and equipping the rods with a swab cup and using valve oil on the swab.

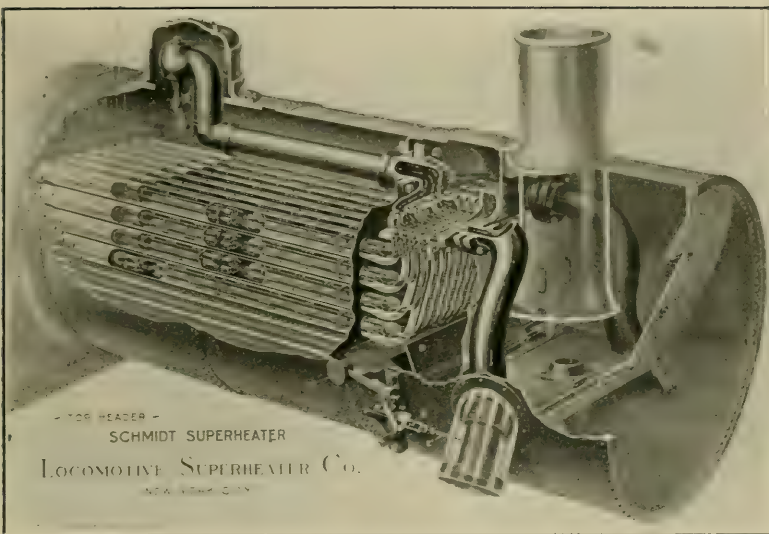
Experiments have been made to find a packing with a higher melting point than that mentioned above and mixtures of lead and copper or brass have been made. The use of packing of this kind, where the mixture of the metals is entirely mechanical, and the benefits desired are not great. If the temperatures are high enough to melt out the lead, it will go out and leave the copper or brass in the form of a sort of honey-comb. Packing made of these mixtures has another disadvantage in that it has a tendency to score the rods. The scoring of the rods is often found to be more serious than the occasional burning out of the packing. As was mentioned above, the place to correct rod packing troubles lies in the correction of the lubrication first.

It has been the purpose of this paper to bring before you, for discussion, the problems that are experienced in the operation and maintenance of superheater locomotives. Only the important items under these subjects have been taken up. Upon the proper maintenance and proper operation depends the possibility of obtaining the savings and the advantages that are offered by the use of superheated steam. While it may appear from the points that have been mentioned that the maintenance of the superheater locomotive is considerable, it is found in actual practice that the maintenance costs are not higher for the superheater equipment than for any other similar part of the locomotive. Experience has also proven that a great many of the troubles that are encountered in the maintenance and operation are due to a lack of experience and may be eliminated if the proper care is taken at the start.

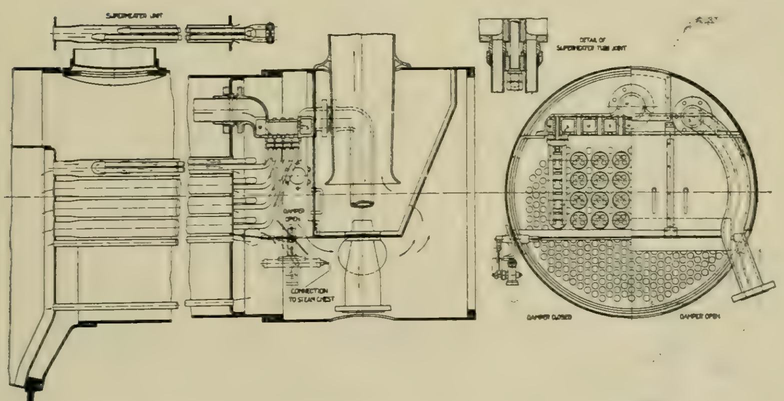
I have a few slides that will show the construction of the superheaters, and I will describe them briefly, and if there are any points that you care to ask that are not clear, I will be glad to answer them while the slide is on the screen.



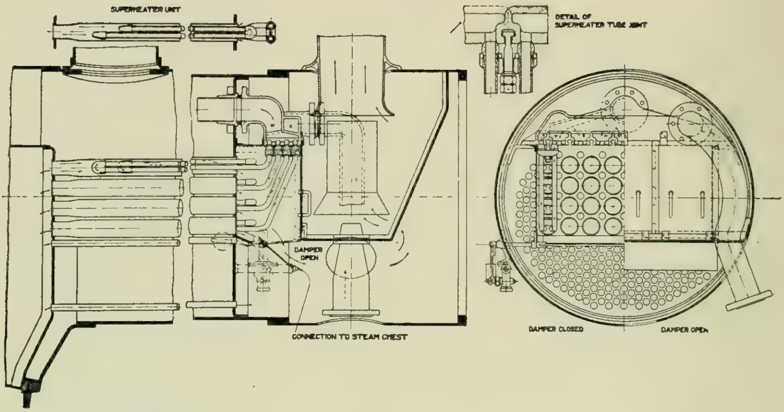
1. Type A top header fire tube superheater applied to locomotives with outside steam pipes.



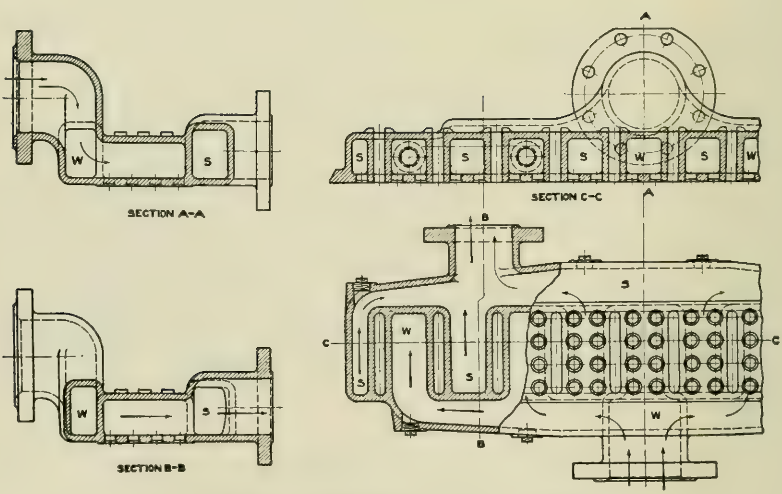
2. Schmidt top header fire tube superheater.



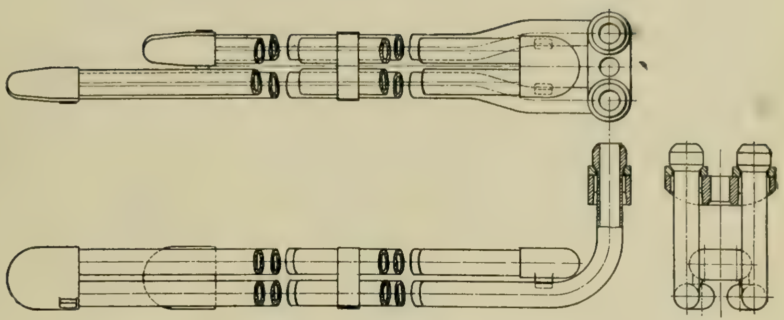
3. Schmidt superheater with top header, having through bolt unit connections.



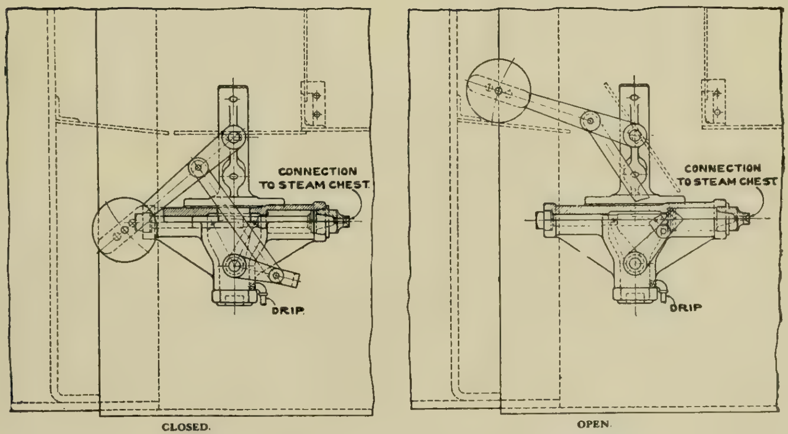
4. Schmidt superheater with top header, having tee bolt unit connections.



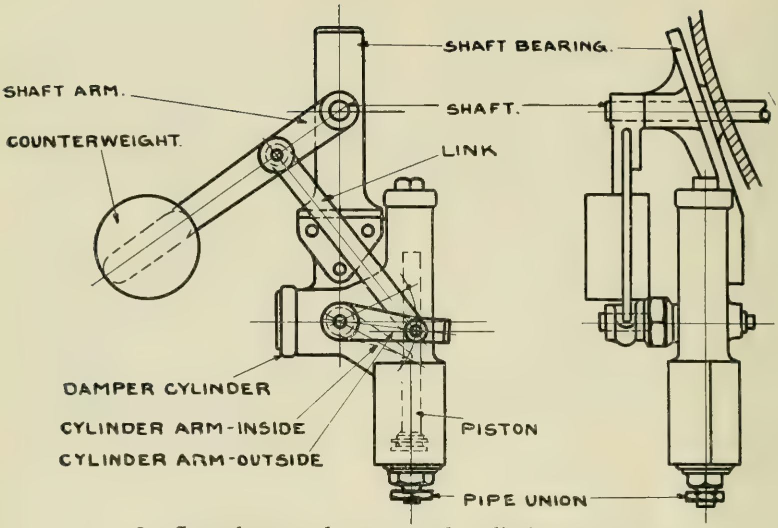
5. Schmidt superheater header casting.



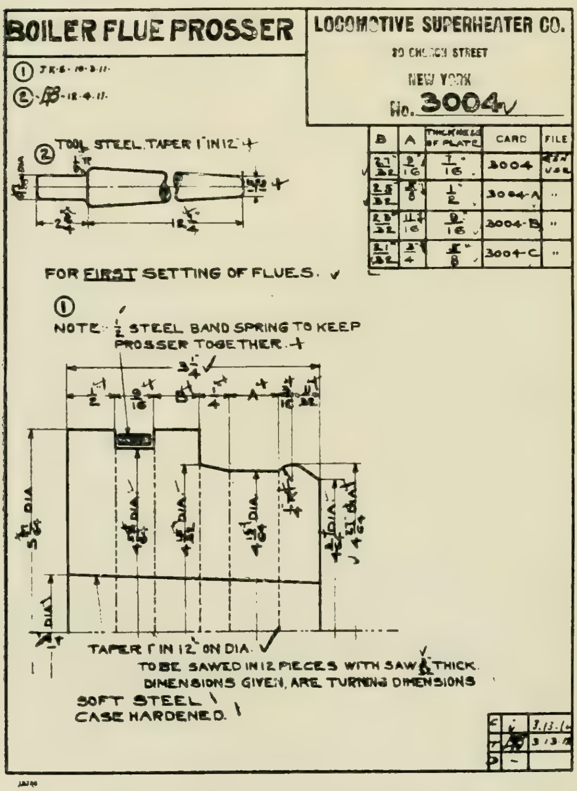
6. Schmidt superheater unit.



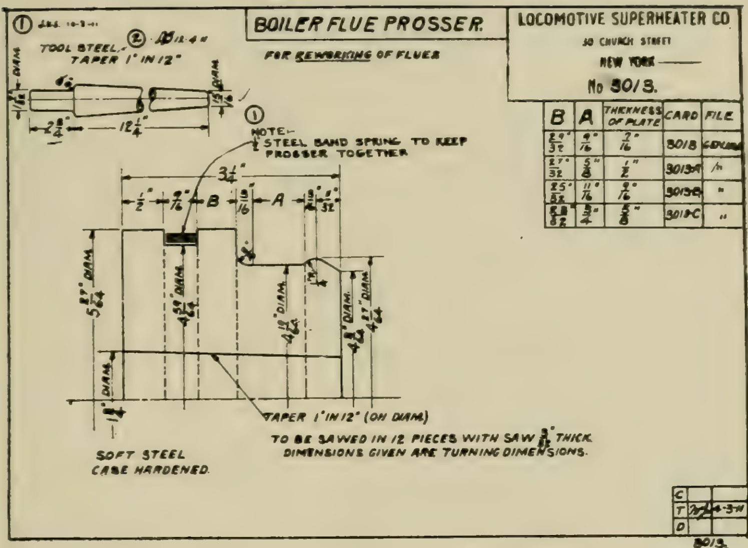
7. Superheater damper and cylinder, horizontal.



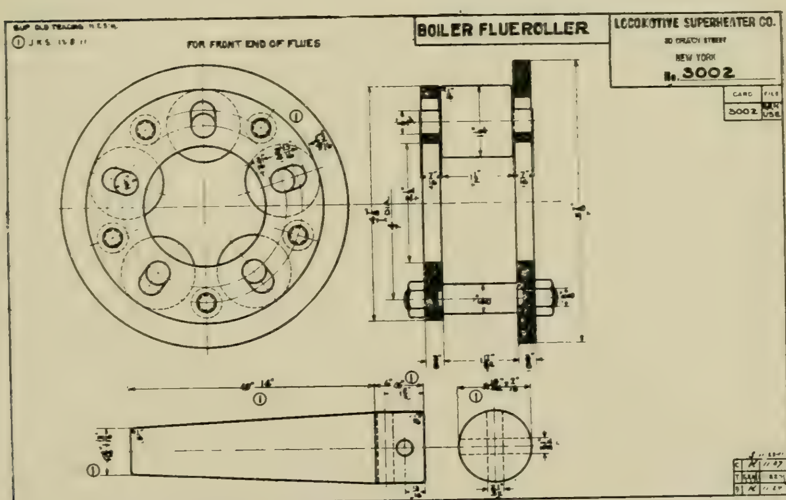
8. Superheater damper and cylinder, vertical.



9. Prosser used in first setting of flues.



10. Prosser used in reworking flues.



11. Roller consisting of five rolls used in maintaining large flues.

PRESIDENT: Gentlemen, this subject is one of great interest to all railroad men that have anything to do with locomotives, and I hope that you will enter into this discussion on the operation and maintenance of the superheater locomotive without waiting for your name to be called. We have no idea from the registery cards as to who are the most interested in this work, but we presume that all persons that have anything to do with the superheater or care to learn anything about them are interested. I will, however, ask Mr. D. J. Redding, Asst. Superintendent of Motive Power, P. & L. E. R. R., to open the discussion.

MR. REDDING: Mr. President and Gentlemen—I had hoped to listen for a while first to people who have objections to superheaters. I have no objection to the superheater. I notice some remarks made by the speaker, however, that I did not quite understand. For instance, I think he said that there was a loss between the superheater and the point of cut-off so that only about 100 degrees of superheat were delivered to the steam chest of a 200-pound pressure engine. That would only give a total temperature of 487 or 488. I am inclined to think that you get very much more than that. I may have misunderstood Mr. Ryder in making that statement, but I am under the impression that it should be around 600 degrees. Of course it does not do to take all the statements made by the superheater people just exactly at face value. For instance, one might think when he said he could save 30 per cent. of the fuel that that meant 30 per cent. of all fuel consumed. The superheater will only save 30 per cent. when you are using steam rapidly. You will not get that amount of saving when your boiler is being fired up or laying around the round house, or over the ash pit.

We have not been able to find that we were saving 30 per cent. in fuel, but possibly that is due to the fact that we have not followed the matter up closely enough, or made sufficiently careful tests, but we do know that we are making a very considerable saving in fuel. Our superheated engines are working at full or nearly full capacity, under which conditions you get best results from superheated steam, and I feel that the use of superheated steam is a very distinct advance in successful locomotive operation, and that it is worth while is further evidenced

by the fact that the manufacturers are receiving a great many orders for superheat equipment.

The matter of leaks at the front flue sheet, mentioned by Mr. Ryder, seems to be serious only when the engines are turned out by the locomotive builders. We have not had trouble with leaks in the front end after we have re-set the tubes, but the builders at first apparently did not realize the importance of doing better work at the front end on superheaters than they had been in the habit of doing on saturated steam boilers. They did not realize the necessity of beading more of the tubes in the front end, but think they are improving in this respect. When we have a first-class job of installation in the superheater engines, we do not feel there is much occasion for leaking flues in the front end. We do not use flue rolls on either saturated or superheated boiler tubes.

On the question of lubrication. We thought at first that we were going to have more or less trouble, and I believe that was the general impression over the country when superheated steam was first introduced. I feel now, however, that most of our trouble was the result of this fear, in fact that we used too much oil, this resulting in there being too much oil in steam chests and cylinders at the time the throttle was closed, and consequently excessive carbonized oil, which would form on bolt heads and ports and choke up the exhaust nozzles. By reducing the supply of oil, we have gotten away from the greater portion of that difficulty, and we have not found it necessary to use any different grade of oil from that which we were regularly using with saturated steam. We did find it advisable to dispense with relief valves, thereby preventing the admission of large volumes of cold air at the time throttle was closed. We also find it advisable to use a drifting valve so that there is always some steam in circulation to support the oil.

This whole question of superheated steam reminds me of a story I read one time about an old master mechanic who had worked on a railroad for a great many years, and finally retired. He had an inscription over his fire-place which read: "In my long and varied experience in railroading, I have had a great many troubles, most of which never occurred."

PRESIDENT: Mr. Ryder, would you prefer to answer the questions as raised, or wait until the discussion is over?

MR. RYDER: I think I would prefer to wait, if it is all the same.

PRESIDENT: We would be glad to hear from anyone who cares to speak on the subject.

MR. W. J. MURPHY: Mr. President, I would like to ask Mr. Ryder why they recommend a heavier ferrule for the back end of the flue than they do for the smaller tube?

PRESIDENT: Mr. J. P. Kendrick, Master Mechanic, B. R. & P. Ry.?

MR. KENDRICK: Mr. President and Members—I came here tonight to listen, and I have gained a good deal of knowledge. I have not got very much to say. We have a large number of the superheaters on our road, and we experience no trouble, although we have not had them a great while. As Mr. Redding stated, we thought at first we could not operate them without a special grade of oil, but we find we are getting along very well with the same grade of oil that is used in our saturated steam engines, and so far we have not experienced any trouble.

PRESIDENT: Mr. W. L. Hudson, Road Foreman of Engines, Pennsylvania R. R.

MR. HUDSON: Mr. President, we have nineteen class K2 engines on our division that are equipped with superheaters, and have found that there is quite a saving effected in fuel and water.. We made a bag-coal test or trial some time ago, comparing a superheater engine with a saturated steam engine; that is, we took into consideration the consumption of fuel while the locomotive was in actual service on the road. There were some trips that a fuel saving of about 26% was effected, also a saving of about 23% in water.

We have not experienced any serious difficulty in lubricating the valves and cylinders of these engines, although we did find it necessary to use a better grade of oil—superheater oil. At first we did not supply quite enough of that. I have an idea, however, that the physical characteristics of our road are responsible for the fact that we could not get as good results with the lower grade of oil. We do a great deal of drifting, and for that particular reason I think we require a better grade of oil than would be required on a road where steam is used practically all the time.

There is one question that I would like to ask Mr. Ryder. I am really not asking it for my own information, but the question has been asked and has been discussed by a number of men whom I know are present tonight, and I would like to have Mr. Ryder answer the question for their satisfaction. Is there any benefit derived from a superheater locomotive in starting a train?

PRESIDENT: Mr. W. H. Holbrook, Road Foreman of Engines, P. C. C. & St. L. R. R.

MR. HOLBROOK: Mr. President, we have ten or fifteen Pacific type locomotives equipped with the superheater, and two of the Consolidated, known as the "H-8." Our experience has been about the same as that spoken of by Mr. Ryder and others. We have found that after some experience the necessity for a high grade oil wasn't as pronounced as it was thought, and it was overcome in a large measure by cracking the throttle in drifting. However, before that was brought out, we renewed several bushings and packing rings; but since that was found to be a remedy we have had very little trouble.

I do not think there is any question about the economy of the superheater. There is quite a difference in saving of coal and water.

With regard to the leaks of the superheater units, we have had a number of cases of the superheater unit joints leaking, and in two cases the superheater unit tube cracking. There seems to be quite a difference as to the location of the leak. In one case I remember the superheater unit tube was cracked some two feet back from the flue sheet, and while it effected the engine some in steam it did not materially hurt it any; and in others again where the ball joint of the superheater leaked, it did effect the engine materially. I think that was due to the fact that it would have more effect on the back than it did on the front end.

PRESIDENT: Mr. B. F. Barnhart, Assistant Foreman of Engines, B. & L. E. R. R.

MR. BARNHART: Mr. President and Gentlemen—As the B. & L. E. Railroad has not at present any superheater locomotives, I could not say anything of interest on the subject.

PRESIDENT: Mr. L. L. Sargent, Assistant Road Foreman of Engines, Pennsylvania R. R.

MR. SARGENT: I can not say anything but what would be favorable to the superheater, except this: You can never tell when the damper is closed when the engine is shut off and drifting at night. That is all I have against it.

PRESIDENT: Mr. John T. Neale, Special Fireman, P. R. R.

MR. NEALE: I do not think I can add anything of interest on the subject.

PRESIDENT—Mr. E. W. Grieve, Instructor of Firemen, P. R. R.

MR. GRIEVE: Mr. President and Members—I have not had a great deal of experience with the superheater locomotive. What I have had is rather interesting with reference to the economy of coal. There are some things I notice that I do not think much of, especially as to starting. If anything, you can start more cars with a saturated steam engine than you can with a superheater. That is about all I can say.

PRESIDENT: Mr. F. M. McNulty, Superintendent of Motive Power, Monongahela Connecting Railroad. Your road is a shifting road principally; I am inclined to think you are interested.

MR .McNULTY: Mr. President, my experience on superheater locomotives is very limited. I came here for the purpose of learning something, for use in the near future.

MR. R. M. LONG: Mr. President and Gentlemen—I was very glad to listen to the valuable paper this evening, and very much interested. No man knows what real good a superheater engine is until he gets into bad water; then it will show him very quickly the results of a superheated boiler. Our men over there, when they get a superheated one, are perfectly satisfield, and they moan considerably when they have to run a "wet one," as they call it.

I would like to ask Mr. Ryder if he has, in his experience, noticed any trouble with dampers warping and not working properly? I saw some men running in off another road with some dampers warped. I attributed it myself to the air coming

through at the cylinder saddle, but I did not know whether they experienced much trouble with warped dampers.

Another thing he spoke of, if I have the figures right, that engine was rated at 5,000 on a 3-10% grade. It must have been a pretty good engine, I imagine from what he said, to get her up from 10 to 35 miles an hour. She is some steamer. I would like to ask a question as to the brick arch, and where they run it—whether they run it against the sheet or a few inches away from it? I have had some experience in the passenger and freight superheated engines, and I will say this for them, that our results are noticeable, the coal saving is great, also the water. But for the saving of coal it makes no difference what kind of an apparatus you put on if you don't put some firemen on that know something about firing. They will pile it in pust the same.

I was very glad to listen to the valuable paper read.

PRESIDENT—Mr. H. H. Ryde, of the Page Woven Wire Fence Company.

Mr. President and Gentlemen: While I am not directly connected with the railway game, yet I have always been interested in it; in fact, you may somewhat imagine when I say that I have subscribed for Locomotive Engineering for over 20 years.

The question of lubrication with super-heated steam is no doubt very important. Last Summer I spent almost two months in Italy, Austria and Greece. While there I was particularly interested in their locomotives; every time I saw an engine I went over to look her over. While this is possibly not quite connected with the discussion, I noticed particularly in Italy one very peculiar type of engine that was designed by that very excellent designer—Ernest Breda—of Milan. These engines were of the Pacific type cylinders 19x32x26, cross compound with cylinders inside the frames, working on crank axles, both pistons having tail rods extending through the cylinder-heads to carry the weight; and I think this is a very good idea, particularly with large pistons. These engines also had an intercepting valve between the cylinders which was used in starting. Walchaert valve gear was used and the piston valves located outside the frames and in line with the valve gear. You can imagine cylinders between the frames and piston valves out-

side the frames—and then imagine the clearance between valves and cylinders. These engines—although unique in their design—picked up a heavy train very rapidly, and I understood they gave very good satisfaction.

Returning to the question of lubrication, I found on some of these engines a very clever method of lubrication which I though was very good. This consists of two small round receptacles placed on each side of the engine—on the running board—which would hold possibly ½ to 1 gallon of oil; attached to these receptacles was a ratchet gear similar in principle to the Rochester Lubricator—which is used in stationary engine practice. This ratchet arrangement was attached to one of the levers on the Walchaert valve gear and forced a small stream of oil to the steam chest; the pipe from the lubricator was piped into a tee on top of the valve chamber and pipes branching from the sides of the tee to each end of the steam chest. I understand they liked the arrangement well.

I also found that in all high-pressures, and particularly with super-heated steam, slide valves were practically abandoned. They appeared to think it the height of folly to use slide valves for pressure over 180 pounds.

The question of lubrication is no doubt very important with super-heated steam. I have some locomotives under my supervision at present using saturated steam and I know how important it is and that it is worthy of a great deal of attention, although I think, as Mr. Redding says, that with superheated steam you often use too much oil.

Gentlemen, I thank you for your attention.

PRESIDENT—We have with us a Boiler Shop Foreman and an Engine House Foreman. As nothing has been said about maintenance, possibly these gentlemen could speak on that subject. Mr. D. S. Rice, Boiler Shop Foreman, P. R. R.

MR. RICE: Mr. President and Gentlemen—I am very much gratified for the privilege of hearing this paper. We are operating a few of the "k" type of engines that have been equipped with superheaters. From a boiler shop standpoint, probably the only difficulty that we experience is frequency of the large super-heater tubes leaking in the firebox end. So far as leaks are concerned in the smokebox, we are not troubled there.

PRESIDENT—Mr. W. A. Jones, Engine House Foreman, Pennsylvania Lines.

MR. JONES: We have about 25 or 30 superheater locomotives in freight service, and have had very good results with them. I do not think we have had much difficulty with the superheater engines possibly because they are new. The engineers all tell me that they have less trouble getting over the road with the superheater engines than they do with the saturated steam engines. We have had no trouble with superheater flues. We have had no trouble with superheater elements leaking in the front end. Some passenger engines have had a few elements leaking. I think if we keep the superheaters up to shape that we will have no trouble with them.

PRESIDENT—I notice the card of Herbert Lewis, District Inspector of Locomotive Boilers of the United States Government. We will be very glad indeed to hear from him.

MR LEWIS: Mr. President and Gentlemen—This paper that has been read tonight is most interesting to all the district inspectors—especially myself. We are vitally interested in this question of superheated steam, from the standpoint of a possible failure. It may come about through the increased size of the superheater tube. It is a well known fact—you are all practical men, in fact all men connected with the locomotive operation of the railroad—that a flue deteriorates just ahead of the weld, on account of the metal not being worked under the course of welding. Now, when you come to put in a superheater flue of about 4½" diameter, which I understand is the size that is to be used and is the standard size, we have an increased area there, and from the statistics it is clear, owing to the number of flue failures that have happened throughout the country, the accidents that have been reported to the Department in Washington, this matter is worthy of considerable consideration.

I would like to be advised if the representative can enlighten the gentlemen present, and myself—I know we are all interested—if there are any particular suggestions wherein we can obtain a higher standard of strength than would be maintained ordinarily with the ordinary process of welding on the smaller diameter of flue? It has been shown in tests by the National Tube Company, tests made for the United States Government, that in many instances the flue weld was not

anywhere near perfection. Of course we know it is not perfection, but some of them are far away from it. And under the best circumstances that could prevail it was found in many instances that the welds would give way. You can all readily realize what it means if a 4½ inch flue cracks completely off in a firebox; it might mean a dangerous accident where many would be injured. What I would like to impress upon the representative is the fact that if these large flues are used, can it be so arranged that any protection could be brought about to overcome injuries of this sort? I would like to have him dwell on that matter and make it clear, if possible. There are many times that I have personally investigated flue accidents, and we find that in 90% of them the flue simply breaks off just ahead of the weld. The weld oftentimes holds good, but that deteriorating of the flue when it comes from the fire, not being worked, causes it to fail at that point. I think you older boiler men present will agree with me on that point.

I believe that the superheater has come to stay; there is no question about it. And as to its maintenance and operation, while I am not directly interested I am interested in another way. I believe it has come to stay, and I believe we ought to know all we can about it. I am here to learn, and would like to hear him enter into a discussion in its entirety. I thank you very much, gentlemen.

PRESIDENT—Mr. Wm. Wittig, Foreman Boiler Makers, American Locomotive Company.

MR WITTIG: Gentlemen, I have come here this evening to learn. While I am a young man, yet I have taken the position as Foreman of Boiler Makers and I find my chief trouble is what Mr. Redding states, applying these tubes, and applying them right, so that they are suitable to the railroad company. And you know that is quite a hard job. I have not found any trouble with the tubes myself; I can not say anything about that part of it; but whether they are pleasing and satisfactory to the railroad companys is another thing.

PRESIDENT: Mr. C. A. Yawman, Fireman on the Test Plant, P. R. R., Altoona.

MR. YAWMAN: Mr. President—I have had quite a little experience in the firing of superheater locomotives, and particularly where they were worked to their capacity, and sometimes

a little beyond. All I can say about superheater locomotives is favorable. We have at times had as high as 662 degrees superheat in the branch pipe with these locomotives on the Test Plant.

PRESIDENT: Mr. W. W. Bond, Assistant Road Foreman, of Engines, P. R. R.

MR. BOND: Mr. President—I have had some experience with the superheater engines and while there is no question but what the saturated steam engine must take its hat off to the superheater, we still have some trouble with the latter. We find too, as Mr. Yawman has just said, that the superheater capacity is not unlimited, and that the cut-off has to be taken care of to a certain extent as carefully as any other type of engines, and we do not find them as has been said, able to stand full stroke at 18 and 20 miles per hour. From an economical standpoint, there is no question but that there is quite a saving,—we find that in tests made.

As to the lubrication, I always felt like asking somebody a question as to whether or not it was advisable to put the oil in the cylinders as they are designed, it has occurred to me that the same amount of oil put through the valves would give better satisfaction than to have a part of it go to the cylinders direct. I would like to have Mr. Ryder say something on this point.

PRESIDENT—We have with us this evening Mr. J. G. Code, General Manager of the Wabash-Pittsburgh Terminal Railroad.

MR CODE: Mr. President, I can add very little to what has been said about the superheater. I have had, however, occasion recently to make a comparison of the maintenance cost between the superheater locomotive and one of a similar type using saturated steam. The factor of difference between the locomotives, we found, was that with the superheated steam locomotive carrying 160 pounds of pressure, with a 25-inch cylinder, and the saturated steam engine with 200 pounds pressure, with a 22-inch cylinder, the cost recorded since April, 1909—all repairs average per annum, or per month—was 86% greater on the saturated steam locomotive. Or, by miles operated, the saturated steam locomotives cost per mile was 121% greater.

This of course cannot all be credited to the superheater, but in part to the lower steam pressure maintained on the superheater engine. We get the same performance out of both locomotives, and that I believe is an interesting feature of the value of the superheated steam locomotive, in that it is possible to get a performance equal, by the use of superheating, to that of a saturated steam locomotive carrying a higher pressure. We have no difficulty with the packing or lubrication.

PRESIDENT: Mr. F. H. Stark, Superintendent Montour Railroad.

MR STARK: Mr. President and Gentlemen—It seems to be the purpose of the President always to extend that courtesy to me, even though he knows I don't know a thing about it. We sometimes have a little prejudice against hypnotists, etc. The gentleman who presented the paper tonight apparently has his company with him. One of them refers to his travels all over the world as fluently as we might about the states in the Union. And somehow or other we are inclined to accept some of the statements that are made with just a little bit of prejudice. Now, personally, if he had explained to us how he could operate the locomotive with a lower grade of coal, I might have been more interested. However, seriously speaking, Mr. Code, I think hit on one of the important advantages; and that is, the possibility of producing the same service with a less steam pressure. That, to my mind, is a very valuable feature of the superheater. And there was one other feature that I did not understand, and that was how the superheater went into action automatically as the service required. I presume that is simple to the rest of you, but to me it was not.

PRESIDENT: Mr. A. Stucki.

MR. STUCKI: Mr. President—We have heard a good deal about dampers tonight. As I understand it, they are allowing an unobstructed passage for the gases in the open position and a partially closed passage in the closed position. One speaker just claimed he didn't know when the damper was open or when it was shut and another one found them often warped.

Are these dampers in superheated steam locomotives always automatically operated or are stationary dampers used at times? Would it not be perferable in some respects to operate

them by hand, then you would be sure that they are shut when you want them shut, and vice versa, then you could also graduate the opening, similar to what has been done with a good deal of success(See R. R. Age Gazette February 14th, 1913) on other locomotives. Or have you used this graduating damper in connection with the superheater?

PRESIDENT: Mr. D. M. Howe, Manager, Joseph Dixon Crucible Company.

MR HOWE: Mr. President—What I don't know about superheating would fill a very large book. I was very much interested in hearing the paper read tonight, and fully as interested in hearing the different questions asked, and I would be equally interested in hearing Mr. Ryder answer the questions that have been asked. It would hardly be proper for me to go into the subject of lubrication, which no doubt I would know a little more about than some of the other points spoken of tonight. However, I am an old member of the Franklin Institute of Philadelphia, and when a fellow got up there to speak about his own goods he was promptly called down, and I am going to call myself down.

PRESIDENT: Mr. W. A. Buckbee, Representative, Locomotive Superheater Company.

MR. BUCKBEE: Mr. President and Gentlemen—While this is my first meeting with the members of The Railway Club of Pittsburgh, I am glad to say that I am here with you, and I might say too that I am glad to hear that the superheater has plenty of friends in this district. In fact I haven't heard anybody say anything very detrimental or anything that would lead to the fact that the superheater was giving as much trouble as was expected. Now, I can frankly say that from my own experience, and I have been practically on the firing line, (as one would say,) I have been surprised with the little trouble we have had. For instance, there is one road in the Eastern country that has nearly 700 superheaters in service, and as Mr. Ryder told you, it has not been necessary to increase the roundhouse staff in taking care of those superheater locomotives.

I am not going to tell you much about the good qualities of the superheaters, because it is too well known to dwell upon. You know the saving in fuel and water and the in-

creased efficiency that the superheating locomotive will give us under proper operating conditions. But there is one point that Mr. Ryder spoke about that I want to talk on. To my mind it is now the most important point in connection with the performance of the superheater locomotive; that is, the operation. We are getting along very nicely with the maintenance proposition. Most of the troubles that have come up in the early stages of the introductiion of the superheater have been overcome, and we are finding that there is very little more trouble so far as maintenance is concerned, than there was with the saturated steam engines. And that is due to the fact that everybody is becoming more familiar with what is necessary. We have got a changed condition, and it is necessary to meet that condition, and we are all learning what is necessary to do to meet it. But the operating condition to my mind is the most important one that we have to consider at the present.

For instance, the firing. I believe I can frankly say that the hardest proposition in connection with the introduction of the superheater locomotive that we have had to contend with is proper firing. Now, there is a reason for that. In the use of saturated steam locomotives, the heavy engines in fast passenger service and heavy freight service, it had about reached the capacity of the fireman and the work of the fireman had become more a question of endurance than that of intelligent firing, but along comes the superheater just at a time it is most needed and we reduce the amount of coal that is consumed per train mile and we have a condition where the comparatively new fireman has got to learn all over again. With a superheater locomotive we have got an entirely different draft condition. We have a lighter exhaust, and it is generally necessary to reduce the nozzle some over that which we use with a saturated steam engine, particularly in freight service. However, that depends in a great measure upon the quality of coal and our operating conditions, and in a larger measure on the intelligence of our firemen and their adaptability to meet new conditions. I want to say, gentlemen, again, that the hardest proposition that I have been up against, is to get the firing conditions right for the superheater locomotives. You talk to the average fireman and ask him how the superheater is getting along and he says she is doing all right. You ask him about the water and he will

tell you she uses about half as much water as the saturated steam engine doing the same work—of course this is exaggerated, but he is only making a guess. But in many instances you talk to him about the amount of coal used and he will say he doesn't see any difference between the two types of engine. He feeds the fire too fast and he is firing the engine with a low flame temperature and wasting the best part of the fuel. I had occasion to meet a fireman some little time ago and there was a question came up that I thought was a very good one. The fireman was turned over to me by his engineer with the remark from the engineer that he would like to have me give him a little information on superheating. The engineer immediately left us, and we happened to be in the call office of a very large terminal. I asked the fireman what he wanted to know about the superheating question, and he said to me, "I thought the superheating engines were intended to burn less coal than the saturated engines." "Well," I said, "that is the intention." He said, "I use as much coal as I do in the saturated engines." I said to him, "How about the water, does she use as much as the saturated engines?" And he said, "No, she only uses about half as much." I said to him, "What do you use the coal for?" "Why," he says, "to heat the water." Then I said, "Why don't you reduce the fuel consumption to compare with the reduction in water consumption?" And he hadn't much more to say on it. By the time we got through talking a lot of the boys were around there and the opportunity presented itself for a lecture on combustion, which I took advantage of.

It has been my experience to note that there is not very much trouble with the engineers carrying the water too high. In most cases the engineers are careful about it and I think it is due in a measure to the great amount of talk there has been on that one subject. But the fireman is the man we have to contend with *always*, because he is a new man, comes on from day to day, and we must teach that fireman that the superheater locomotive must be fired with a light fire and with small quantities of fuel. And when we do that we will get the efficiency and economy of the superheater locomotives. If we don't get a high flame temperature in the firebox we don't get the superheat and we don't get the full efficiency of the superheater locomotive.

Mr. Ryder stated a case, in which it was difficult to get the engineer to understand that the superheater locomotive could be worked much harder than a saturated locomotive. He had been operating a saturated steam locomotive and he knew where the limit of the boiler was, but he did not know that the introduction of the superheater on that same engine was equivalent to increasing the boiler. The engineer must not be afraid to work the superheater engine; he should not be afraid to get the throttle out.

The enginemen as a rule are very favorable to the superheater locomotives. There are many reasons why they should be, but we have a campaign of education before us to teach them to get all there is out of the superheater.

Now, gentlemen, I would like to hear more of the troubles that are exeperienced on the road, and the steam failures. I know we have them. We are going to have steam failures with superheater engines as we do with other engines, and while we are glad to hear good reports we also want to know all about the troubles, so that we can do all that is possible to eliminate them.

I want to thank you for the privilege of talking on the subject, and for your appreciation of the valuable paper which our friend, Mr. Ryder, has presented.

I thank you, gentlemen, for the privilege.

PRESIDENT: Is there any other gentleman who has anything to say on the subject or any questions to ask?

MR. H. B. KELLY: Mr. President, in listening to all the speakers here tonight there is one point that I have not heard any of the speakers bring up. It is in regard to the smoke matter. We all know that we have a smoke ordinance in the city of Pittsburgh that is rather difficult at times to live up to. From my experience with superheater engine, I find a great advantage over the saturated steam engine in regards to keeping down the smoke. I attribute this to the efficiency of the superheater over the saturated steam engine. In regards to coal and water, we have eleven superheater engines on the road on which I am employed (the P. & L. E. R. R.), and from my actual experience I would be safe in saying that there is a saving of 25% in coal and water over the saturated steam engine. We made a coal test

about a year ago on a superheater and a saturated steam engine on one of our passenger trains between Pittsburgh and Youngstown, a distance of 66 miles. The train consisted of nine cars, made four stops; schedule running time of one hour and thirty minutes. The superheater engine used 117 scoops of coal, the saturated steam engine used 189 scoops of coal (the average weight per scoop is 18 pounds). In regards to firing the superheater engines, I find this a very important feature. To get the best results you must carry a bright, level fire and fire with not more than four or five scoops of coal to each fire, allowing the smoke stack to be cleared thoroughly between each fire, as it is very necessary that the fires be kept in this manner, as heavy firing is most generally the cause of superheater flues leaking.

MR. F. S. ROBBINS: Mr. President, there is one question I would like to hear talked on in regard to the superheater engines, and that is the care of valves when drifting. Certain men here have indicated the use of a drifting valve, some have relief valves, and some have by-pass valves. Of course, the relief valves all admit cold air. The cracking of the throttle valve may be practicable under some conditions where the physical characteristics are all right, but try it on 2% grade and we are up against a different proposition. If Mr. Ryder has anything developed in this line, I should like to hear it, because I believe the lubrication troubles are all caused at the time when the throttle is closed and the engine is drifting.

MR. HOLBROOK: Mr. President, I would just like to ask a few questions in this line—it is about on the same line as the gentleman has just spoken of. Is there a valve developed yet that will automatically set steam to the engine when drifting? That is where we find out greatest trouble, in trying to crack the throttle when drifting.

MR. REDDING: I would like to have Mr. Ryder tell us when he is answering these questions, whether he has learned in following up this work, if it has been found advisable or good practice to weld the superheater tubes into the tube sheets?

PRESIDENT: We will now ask Mr. Ryder to answer the questions which have been asked, after which, if there are any further questions to be raised, you will be given an opportunity.

MR. RYDER: Gentlemen, I am very much gratified with

the number of valuable points that you have brought out in the discussion of this paper.

Going over the questions that have been raised in the discussion, I will first take up the points raised by Mr. Lewis, who mentioned something about the statistics pertaining to flue failures that have occurred throughout the country, and to these statistics I would like to add a few more.

At the present time there are something over seven thousand locomotives in service equipped with superheaters. The number of large flues in each of these locomotives can be averaged at about thirty for each locomotive, or twenty-one thousand all told. The success of the superheater became established about three years ago, and from that time to the present they have been applied to a large percentage of the locomotives built.

If the flues are safe ended at the end of a year's service, which would represent very fairly the practice that is followed, it is reasonably presumed that two-thirds of the superheater flues in service have been safe-ended; that is, there are today about 140,000 welded superheater flues in locomotive boilers. With this large number of welded flues we have yet to hear of the first flue to fail in the weld while the engine was in service. It is logical to presume that there have been no failures of this character. Had there been such failures, we would more than likely have heard of them, since these conditions come to our attention with but very little delay. I cannot help but feel that there is very little probablity of any considerable trouble arising from this source. A remark was made in the discussion of another point which is appropriate to apply to this one; that is, that troubles along this line are principally troubles that never exist.

With reference to the point which Mr. Redding raised, regarding the temperature of the steam in the steam chest, I possibly did not make myself quite clear with reference to this point. What I intended to convey was that if the steam left the superheater with say 250° of superheat it had left about 100° of superheat at the point of cut-off. Temperature readings have been taken in the steam pipe and the steam chest up to 600° and 650°, but the temperature of the steam in the cylinders at the point of cut-off is quite another thing. There is a great deal of heat given up to the cylinder walls upon the admission of steam into the

cylinders, due to the low temperature of these walls. The admission end of the cylinder is the coldest part of it by reason of the fact that it was the exhaust end immediately previous to the admission, and the temperature of the exhaust steam is, of course, comparatively low. The great drop in temperature is due to the heat given up to the cylinder walls, and with 250° of superheat in the steam chest it is estimated that there would remain about 100° in the cylinders at the point of cut-off. The remaining superheat is sufficient, however, to carry the steam throughout the stroke and into the exhaust before the point of saturation is reached.

It was stated in the discussion that the superheater locomotive would do all that was claimed for it in the way of coal saving while the engine was using steam, and that there was no saving over the saturated engine while the locomotive was fired up and not actually using steam.

The claims made for the saving that is obtained by the use of superheated steam are not based upon the actual time that the engines are using steam, but upon the amount of coal that the engines use when in identically the same service with the saturated engines. Upon this basis the idle time of the superheated steam locomotive while under steam would be practically the same as that of the saturated locomotive. To state this concisely, the superheated steam locomotive will save from 20% to 25% in coal under average conditions when compared with a saturated steam locomotive of the same general dimensions and in the same class of service. If the coal saving is considered on the basis of the time that the engine is actually using steam the saving made by the superheater locomotive is considerably larger.

With regard to Mr. Kelly's question as to the effect of the use of locomotives equipped with superheater on the reduction in smoke, I would say that it has been found that locomotives equipped with this device operate with considerably less smoke than saturated steam engines in the same service. This is probably due to the fact that the superheater locomotives burn considerably less coal than saturated locomotives and consequently more attention can be paid to the practice of better methods of firing. This has been found to be especially true of switch engines equipped with superheaters. By careful methods of firing

superheated switch engines operating in passenger terminals have been made to operate almost smokelessly.

Since the subject of superheater switch engines have been mentioned, I would like to say just a word or two upon the advantages that are obtained from the use of superheaters in this service. Up to about a year and a half ago it was not considered good practice to equip switch engines with superheaters, it being thought that in short work, where the operation is very intermittent, the value of the superheater would not be realized. The Lake Shore & Michigan Southern Railway, however, decided to equip two switch engines with superheaters, in spite of the sentiment which prevailed against the practice. These locomotives were equipped with superheaters and put in service in each of the passenger terminals at Cleveland and Chicago. The results that were obtained by these engines were so favorable that many other roads have adopted the use of superheated steam in switching service, and within the past year and a half there have been over three hundred switch engines ordered with superheater equipment.

The saving obtained by the superheater in switching service is probably not due to the high degree of superheat that is obtained; it is rather to be accounted for by the possibility that the saturated steam switch engine offers for saving. The ordinary switching engine using saturated steam is no doubt one of the most uneconomical locomotives that the railroad companies operate. The steam space in the boiler is small and this, with the fact that the throttle is generally opened completely and the lever operated in the corner, makes the priming tendency quite considerable. The loss due to water carried over into the dry pipe is high with this class of power and the cylinder condensation is also much higher than a locomotive which operates continuously for a considerable length of time. The higher condensation losses are due to the intermittent operation of the engine, thus allowing the cylinders to be cooled while the engine is standing, entailing a considerable loss of heat by reason of the fact that the cylinders must be heated again when the engine is started.

The superheater in the switch engine may be considered practically the same as an auxiliary boiler; that is, the water carried over into the dry pipe, due to the priming, is evaporated

as it passes through the superheater; sufficient heat is also added to the steam while in the superheater, to carry it through the cylinders and into the exhaust with a great reduction in cylinder condensation. Inasmuch as the condensation losses and the losses due to priming, in the operation of saturated steam switch engines, amount often to 30% and 40% of the water evaporated, the introduction of the superheater, which entirely eliminates these losses, results in a corresponding saving in coal.

The reason why a copper ferrule of greater thickness is used in the large flues than is ordinarily used in the small boiler tubes is because the large flue is of considerably heavier gauge and the service on the ferrule is harder. Because of the heavier gauge, and the larger diameter of the flue, it is necessary to work the flues a little harder than the small boiler tubes, and it is found by experience that heavier copper in the ferrule will stand up better under these conditions than the lighter ferrule.

With reference to the point raised by Mr. Hudson that they require better oil on account of road conditions which exist on his road, I would say that in conditions where the maximum benefits are being derived from the use of highly superheated steam then an oil with a higher flash than that ordinarily used in saturated practice should be used. If it is possible to operate locomotives with a grade of oil that has a carbonizing point or flash point much below the temperature of the superheated steam, the operating conditions are so highly perfected that there is always steam in the cylinder to protect the oil when it is at a temperature above its carbonizing point. If the operating conditions are not perfected to this point and it is possible to operate the superheater locomotive satisfactorily with oil of lower carbonizing or flash point, it probably follows that the engines are not being worked to their maximum capacity; that is, the advantages offered by the use of highly superheated steam are not being obtained. There are many causes which will produce this effect. The flues may be stopped up, the damper may not be operating properly, it may be that the water is being carried too high in the boiler, the engines may be operated with a light throttle or with a short cutoff, all of which will contribute to the inefficient operation of the superheater. In short, if the engines are operated under conditions where the advantages are being obtained, it will be found necessary to use an oil that will stand

up against the high temperature. As to the extra cost of this higher grade of oil when balanced against the cost of cylinder and valve bushings and rings, it will be found to be comparatively nothing. An extra cost of five or ten cents a gallon for oil will soon be more than balanced by the cost of bushings and rings, together with the cost of their application.

As to whether the superheater locomotive will start more cars than a like saturated locomotive, can be answered simply by no. I brought out in the paper that the addition of heat to the steam or the superheating of the steam does not increase the mean effective pressure in the cylinder. The pressure against the piston is the same with superheated steam as with saturated, and consequently the superheater locomotive will not start any heavier train than will a saturated locomotive of the same size operated under the same conditions. It will, however, pull the same train at a considerably higher speed. In the majority of cases the tonnage rating of the locomotive is not based on the number of cars that the locomotive will start, but upon the number of cars that it will haul at a given speed. Under these conditions the number of cars or hauling capacity of the locomotive is based upon the capacity of the boiler.

By the use of highly superheated steam the boiler capacity is increased in proportion to the saving in water obtained, which amouts to from 25% to 35%. By reason of this increased boiler capacity the superheater locomotive can be operated at longer cut-offs, thereby developing higher speeds with the same tonnage as the saturated locomotive of the same dimensions, or it will haul heavier trains at the same speed. It is interesting to note, in this connection, that while it is possible to haul heavier trains or maintain faster schedules with the superheater locomotive, that it is done on the same amount of coal and consequently does not increase the work of the firemen.

I have already mentioned that we have yet to learn of the first flue to fail in the weld. To my knowledge there have not been any flue failures due to service conditions. There have been some failures in flues at the firebox end while they were being prossered. These failures were due to improper annealing of the swaged portion of the flue after the swaging had been done. If the flues are swaged and not properly annealed it leaves the metal hard and brittle and in this condition is liable to

crack when the prossering is being done. The manufacturers of flues furnish them already swaged and are taking care of this condition now by seeing that the flues go through the proper annealing process before they are delivered. If any flues are swaged in railroad shops, it is advisable to see that they are properly annealed before they are put in the boilers.

An interesting point was raised by Mr. Sargent in regard to the operation of the damper and the difficulty of finding out whether the damper was open or closed while running at night. When the damper is closed the superheater and a large percentage of the tube heating surface becomes inactive; that is, the combustion gases must necessarily pass through the portion of the flues not closed off by the damper. An engine operating with the damper closed will soon appear to be steaming poorly, and it seems hardly possible that an engineer could go very far without knowing that something was wrong. When this condition occurs the first thing to be done is to find out whether the damper is open or closed. If it is found that the damper does not open properly, and this can be noted from the position of the counterweight which is down when the damper is closed, it should be tied in an open position until the end of the trip and the condition of the damper reported at the terminal. It is better to tie the damper open for the remainder of the trip than to have an engine failure.

MR. SARGENT: May I interrupt for just a minute? I think you have misunderstood what I meant. I have always understood and all the instructions I have ever heard was that the damper should be closel when the throttle is shut off, to prevent injury to the superheater tubes. Now, then, if the engine is drifting for any great distance, and if for any reason the damper should fail to close, the tubes are liable to be damaged, while if the engineman could tell that the damper was not closed he could open the throttle a little, which would prevent damage to the tubes. That is why I raised the point.

MR. RYDER: While it is improbable that the units would be damaged by one trip over the road, it is recommended that the throttle be cracked so that a little steam will pass through the superheater while the engine is drifting. While this practice is not recommended particularly to save the units from damage due to overheating, but rather than to assist in the lubrication

of the valves and cylinders, while the engine is drifting, it will help to prevent the damage of the units when the damper sticks open.

As to the manner of application of the brick arch, the practice of leaving a clearance space at the flue sheet is predominant, but whether this is the best practice or not depends entirely upon the working conditions. If the conditions are such that there is no tendency for cinders to accumulate on the arch and thereby plug the bottom flues, the arch should most assuredly be set tight against the flue sheet, as this is the ideal practice. Furthermore, if there is opportunity for removing any accumulation which might accrue before the amount of accumulation becomes serious, and if the roundhouse practice is such as to insure thorough cleaning of the arch at frequent intervals, the practice of setting the arch against the flue sheet is the best. On the other hand, if engines work day and night for long periods at a time, the result, under such conditions, is a bank of cinders on the arch and the clearance space must be resorted to. In other words, an accumulation of cinders which banks up the bottom flues must be avoided. If this can be accomplished and still run the arch against the flue sheet, it should be done. If it can be avoided only by means of clearance space, then the clearance space should be allowed.

It may be said, in general, that the use of the brick arch in connection with the superheater tends to increase the efficiency of the locomotive as a whole. The brick arch provides a longer time for the gas to burn in the firebox, thereby resulting in a higher firebox temperature and a higher temperature of the gases in the flues, which, of course, means higher degrees of superheat.

Some one spoke of the use of superheaters in locomotives equipped with slide valves. This has been tried in three instances that I know of in this country, and to my knowledge in only one of the instances has it met with any degree of success. This engine is a large Consolidation engine in freight service. It is equipped with a heavy slide valve and has been running for two or three months. The reports so far are that the performance is satisfactory and that it has not been necessary to face the valves or the seats. The valves, however, are equipped with a unique lubricating arrangement. The oil pipe is branched and

oil admitted to the lower face of the valve through ports drilled through the bridges and holes drilled from the surface of the seat into these ports. The other two instances of which I speak consisted of trials of light high-speed engines in passenger service. In one case it was necessary to face the valves at the end of each trip and the wear was so excessive, in spite of the fact that several kinds of metal were used, that it was found necessary to discontinue the practice after two or three months.

The maintenance figures mentioned by Mr. Code, of the Wabash-Pittsburgh Terminal, are very interesting and all that could be hoped for. Mr. Stark, in his discussion, covered the point which I would have made with regard to these figures. I feel that Mr. Code is entirely justified in his view that all the saving in maintenance cannot be credited to the superheater or at least cannot be credited directly to the superheater. To carry the point a little further, it is true that the superheater has made possible the operation of locomotives with lower boiler pressures, and lower boiler pressures mean, of course, lower boiler maintenance costs. Because of the fact that the superheater entirely eliminates cylinder condensation, it is possible to use cylinders on superheater locomotives that would be prohibitive on a saturated steam locomotive because of the condensation losses that would result from the use of the large cylinders with saturated steam.

In reply to Mr. Stucki's question as to whether there were manually operated dampers, I would say that there are none to my knowledge. The method generally used is to connect the damper to the steam pressure, either in the steam pipe or the steam chest, whereby its operation will be simultaneous with that of the engine throttle, and the damper will be opened when the engine throttle is open and closed when the throttle is closed.

In special cases, such as switching engines, the dampers are operated in conjunction with the blower; that is, the damper cylinder steam pipe leads from the blower to the damper cylinder so that when the blower is in operation the damper will be closed, and when the blower is shut off the damper will be open. This practice is followed in switch engines, because there is very little drifting and the liability of damage to the superheater units while the engine is drifting is eliminated. As to the graduation of the damper, that is, arranging it so that it can be adjusted

and opened only partially at times, it has not been found necessary to provide any means of graduating it. In fact, when the engine is in operation and there is a demand for superheated steam, it is desirable to get as high a degree of superheat as possible. The regulation of the damper would then mean the regulation of the amount of superheat obtained, and inasmuch as it is desirable to get all the superheat that is possible, it is, of course, desirable to have the damper open as wide as it will when it does open. In short, there should be two positions of the damper, that is, completely closed when the throttle is shut off and wide open when the throttle is open and the engine is using steam.

MR. STUCKI: What I meant to ask was, have you ever operated them by hand and have you ever made them graduated?

MR. RYDER: While it is entirely possible to arrange a damper that could be operated by hand, the necessity for it has never arisen. If it were made to operate by hand it would be necessary to depend upon the engineer to operate it and would mean one more duty added to the large number of things that he has to attend to already.

There are no automatic drifting valves on the market that I know of, nor do I know of any in use which are entirely automatic in their operation. There are some that are partially automatic, that is, they will open when the engine throttle is closed, but it is necessary for the engineer or fireman to shut them off after the engine stops. The disadvantage of this drifting valve lies in the fact that the engineer may forget to shut off the dyrifting valve after the engine stops and steam be admitted to the cylinders sufficiently to move the engine and possibly injure some one. The engine dispatcher might leave the engine in the house with the drifting valve open and the engine start of its own accord, running through the wall of the house or back into the turn-table pit. An automatic drifting valve, to be of value, must be so worked that it will open automatically when the throttle is closed and close automatically when the engine stops or has reduced speed to a point where the carbonizing of the oil in the cylinders is not possible.

The practice of welding superheater flues into the firebox flue sheet is being carried on to a considerable extent on a few roads. The Lake Shore & Michigan Southern has welded sev-

eral of them by the lectrical welding process and has obtained good results from the practice. The method that is followed on this road is that of rolling, prossering and beading the flue in the sheet in the ordinary way and filling in around the edge of the bead with metal, which acts as a seal and keeps the flues from leaking. This practice has been very successful, and I understand they are getting excellent results with welded flues on this road.

Is wish to thank you, gentlemen, very much for the privilege of presenting a paper to your Club and for the good discussion that it has produced.

MR. A. W. CROUCH: Mr. President and Members—Mr. Ryder has certainly presented a very excellent paper to us to-night. And it has brought out some splendid discussions that I am sure are interesting to all. I, therefore, move that we give him a vote of thanks.

The motion prevailed, and a vote of thanks was tendered Mr. Ryder.

Meeting adjourned.

J. B. Anderson
Secretary.

OFFICIAL PROCEEDINGS

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, MARCH 28th, 1913.

The regular monthly meeting was called to order by the President, Mr. A. G. Mitchell, at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Altman, C. M.
Anderson, J. B.
Babcock, F. H.
Boyer, Chas. E.
Coulter, A. F.
Courtney, D. C.
Courson, C. L.
Dalton, C. R.
DeArment, J. H.
Detwiler, U. G.
Doty, W. H.
Gale, C. H.
Gowdy, H. K.
Grove, E. M.
Harriman, H. A.
Haynes, J. E.
Herrold, A. E.
Hoffman, Chas. T.
Howe, D. M.
Howe, H.
Jenney, Jacob
Kensinger, E. A.
Kinch, L. E.
Kinter, D. H.
Kleine, R. L.
Lanning, J. F.
Lowe, W. D.
Lynn, Saml.
Mason, Stephen C.
Maxfield, H. H.
Mitchell, A. G.
McFeatters, F. R.
McIntyre, G. L.
McNaight, A. H.
McNulty, F. M.
Newman, J. F.
Noble, H. S.
Painter, Jos.
Partridge, F. G.
Pickels, H. D.
Robbins, F. S.
Ross, Coleman B.
Runser, K. W.
Ryan, W. F.
Ryman, Frank
Smith, John H.
Stark, F. H.
Stucki, A.
Suhrie, N.
Taylor, Frank C.
Thompson, C. H.
Toomey, J. H.
Voight, A. J.
Walther, G. C.

VISITORS.

Anderson, H. A.
Blake, F. H.
Boring, T. J.
Cook, Arthur
Hays, M. D.
Holt, James
Hostettler, L. W.
Keller, W. L.
Lewis, Thomas
Merscher, J.
Nelan, E. J.
Peiffer, C. E.
Pfeiffer, C. A.
Smith, A. R.
Smith, E. M.
Smith, H. J.
Towson, Thos. W.
Turner, J. A.
Whiteford, A. A.
Yergy, J. P.

PRESIDENT: The roll call will be dispensed with as we have the record by registry cards of the attendance. The minutes of the February meeting being in the hands of the printer and about ready for distribution, we will eliminate the reading of the same. The next in order is the reading of applications for membership:

SECRETARY: Mr. President, we have the following applications for membership:

Brennan, E. J., Master Mechanic, B. R. & P. Ry.,DuBois, Pa. Recommended by Geo. A. Gallinger.

Cole, Joshua T., Engineman, P. R. R., Derry, Pa. Recommended by S. G. Glassburn.

Denham, T. B., Chief Clerk, Eng'r Dept., Pressed Steel Car Co., 35 Howard St., Bellevue, Pa. Recommended by Felix Koch.

Hays, Milton D., President, Dukesmith Air Brake and Manf'g. Co., 730 Wabash Bldg., Pittsburgh, Pa. Recommended by D. C. Courtney.

Hilferty, Chas. D., Rep., Locomotive Superheater Co., P. O. Box 34, Chautauqua, N. Y. Recommended by Gilbert E. Ryder.

Holt, H. B., Sales Engineer, Rosedale Foundry and Machine Co., 1318 Fallowfield St., Beechview, Pittsburgh, Pa. Recommended by J. B. Anderson.

Lamb, E. H., General Water Foreman, Union R. R., Port Perry, Pa. Recommended by C. H. Thompson.

Longnecker, John S., Rep., E. A. Wilcox Mfg. Co., Jackosn Road, Crafton, Pa. Recommended by A. A. Shook.

Miller, C. R., Genl. Manager, Fort Pitt Chemical Co., 202 So. Highland Ave., Pittsburgh, Pa. Recommended by R. H. Ward.

McGough, M. F., Clerk, P. R. R. Co., 7012 Monticella St., Pittsburgh, Pa. Recommended by Jos. G. Backoski.

Overly, C. F., Dist. Manager, Pittsburgh Pneumatic Co., 7341 Hamilton Ave., Pittsburgh, Pa. Recommended by F. M. McNulty.

Spellan. Jas., Road Foreman Engines, B. R. & P. Ry., DuBois, Pa. Recommended by Geo. A. Gallinger.

White, A. B., Asst. Supt., B. R. & P. Ry., Punxsutawney, Pa. Recommended by Geo. A. Gallinger.

Wickham, Chas. M., Traveling Engineer, Locomotive Superheater Co., 108 Park Place, Schenectady, N. Y. Recommended by John P. Neff.

PRESIDENT: As soon as these names have been approved by the Executive Committee the gentlemen will become members of the Club.

The Secretary read communications from Mr. Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, and Mr. R. V. Wright, Managing Editor, Railway Age Gazette, extending an invitation to the members of the Club to be present at a meeting of the American Society of Mechanical Engineers on the evening of Tuesday, April 8th, in the United Engineering Society's Building, 29 West Thirty-ninth Street, New York, at which time papers will be read and discussed on the "general topic of steel passenger car design, including electric lighting and electrical equipment." On motion the communications were received and filed and the thanks of the Club expressed for the invitations. The President asked that as many of the members of the Club as possible who are interested in steel car construction attend this meeting.

The Secretary announced that he had received a communication from Mr. Walter V. Turner, Chief Engineer, Westinghouse Air Brake Company, stating that the subject of the paper for the April meeting of the Club is "The effect of changed operating conditions and modern rolling stock on the brake, and what is being done to make this money-saving or money-losing apparatus as efficient as heretofore."

MR. F. R. McFEATTERS: Mr. President, owing to the disastrous floods in the adjoining State, it is thought that The Railway Club of Pittsburgh should contribute something toward the sufferers, I therefore offer a motion that The Railway Club of Pittsburgh contribute the sum of $100.00 toward the relief of the flood sufferers.

MR. A. STUCKI: I certainly think this is the proper thought at the proper time, and therefore second the motion.

The motion was put to vote and carried unanimously.

PRESIDENT: I am very glad, indeed, that this action has been taken, the suggestion being made by the Executive Committee. It is particularly gratifying that a contribution by this Club should be made to such a worthy cause.

Next in order will be the discussion of the "Report of the Standing Committee on Revision of M. C. B. Rules of Interchange." I will ask the Chairman of the Committee, Mr. R. L. Kleine, to present the report, and would suggest that we act upon it seriatim, and discuss each rule as we go along.

Annual Report of Standing Committee on Revision of M. C. B. Rules of Interchange.

Mr. President and Gentlemen:

Your Standing Committee on Revision of M. C. B. Rules of Interchange held its annual meeting February 25th and 26th, 1913, at the Monongahela House, Pittsburgh, to consider the recommendations for changes in the M. C. B. Code of Interchange Rules. The Secretary of the Club issued the usual circular of inquiry to the members under date of February 5th, 1913, to which four replies were received, which were considered with the recommendations from the members of the Committee and the results of the deliberations included in this report.

After issuing the 1912 Code of Interchange Rules, effective September 1st, 1912, Circular No. 8, dated Chicago, Illinois, October 10th, 1912, was issued by the Secretary of the M. C. B. Association, modifying the rules in important details, which has resulted in a considerable amount of confusion and misunderstanding and your Committee feels that after the Rules have been revised and approved at the Convention no radical changes should be made in same during the year, except to correct errors or clear up misunderstandings.

The M. C. B. Committee on Prices for Labor and Material was continued for another year in order to enable them to complete their work. This Committee issued M. C. B. Circular of Inquiry No. 23, dated January 22nd, 1913, asking for recommended changes in labor and material prices, replies to be made

to Mr. F. H. Clark, General Superintendent Motive Power, B. & O. Railroad, not later than March 1st, 1913. This circular was received by some of the members of your Committee on February 24th, 1913, the day before our meeting, whereas, other members had not received the circular at the time of meeting, which precluded giving the consideration to this subject that it deserves. We have, however, acted upon a number of the items included in this circular of inquiry.

Mr. W. McGraw, Superintendent of Car Service, Jamison Coal and Coke Company, presented in person the following letter, dated February 17th, 1913, at the meeting of your Committee:

JAMISON COAL AND COKE COMPANY.

Pittsburgh, February 17th, 1913.

To the Committee of Revision of M. C. B. Rules, The Railway Club of Pittsburgh, Pittsburgh, Pa.:

GENTLEMEN:—In reply to your circular letter in reference to recommendations for changes in M. C. B. Rules, I beg to suggest the following:

The elimination of the additional 10% to total of bill, for the following reasons:

First—The prices as shown in the book of rules are all high enough for the railroads to make a fair margin of profit on the work, without the additional 10%.

Second—By adding this 10% you have added a hardship on the private line owner, which is not justified, as the private line owner is a customer of the railroads, who must pay for the cost of maintenance, interest on money invested and depreciation, the railroad receiving freight, just the same as if they had to pay the cost of maintenance, interest and depreciation, and for this the private lines are only allowed 6/10 of one cent per mile empty and loaded movement. The railroads maintaining an arbitrary stand on this allowance of 6 mills per mile, whether the car is 40,000 capacity or 100,000 capacity, which on its face is unfair, as the investment and depreciation is considerably higher on 100,000 capacity car than on a 40,000 capacity; and the railroad earns considerably more in freight charges.

Notwithstanding the above facts the Master Car Builders have added the burden of 10% to the cost of maintenance.

Third—Our relationship with the railroads is not reciprocal, the 10% is an additional cost to us, while with the railroads it is reciprocal, and it makes no difference whether an item is charged at one dollar or two dollars, as the same article is charged against them at the same amount.

Yours very truly,

(Signed) W. McGRAW,
Superintendent of Cars.

Mr. McGraw further stated that the addition of 10% to the car repair bills without any increased mileage earning to the individual car owner, is a hardship and cited that the value of the cars which they maintain is $1.700,000.00 (representing 1,500 cars), and the expense of maintaining these cars is $60,000.00 per year, or $40.00 per car per year.

Your Committee gave careful consideration to Mr. McGraw's letter and remarks and discussed the matter with him, the Committee arriving at the following conclusions:

First—That the present prices for labor and material, even with the addition of 10%, taking the items collectively, do not provide a margin of profit on the work. Your Committee would recommend that the prices for material and labor in the interchange rules be based on the following:

Material:

Average price of article covering a given period of time.

Plus

Average freight charges on material from manufacturer to railroad or car owner.

Plus

Storehouse expense for handling.

Plus

Labor preparing material for application to cars, including proportion of shop expense.

Labor:

Actual cost prices,

Plus

Shop expense covering uncharged time, fuel, power, heating, lighting, etc.

Plus

Percentage covering interest on valuation of plant and tools, as well as depreciation on plant and tools where cars are repaired, based on productive labor.

Labor and Material:

Add a stated percentage to each item as an incentive to car owners, whether railroad or individual, to maintain his cars in proper condition.

Second—The question of increased compensation for car mileage for individual cars is out of the jurisdiction of this Committee, as well as the Master Car Builders' Association.

Third—While it is true that in general the charges for repairs to cars are not reciprocal between the railroads and the individual car owner, neither is it entirely reciprocal between railroads. In the latter case it all depends on how much work a railroad expends in maintaining foreign cars while on its lines, compared with the repairs made to its cars while on foreign lines. In some cases this is in the ratio of 3 to 1. The individual car owner who maintains his own cars avoids the railroad charges for owners' defects very largely and is exempt from the burdens of combinations of defects and rough handling, which latter must, under the rules, be borne by the railroad company handling the car.

Under date of January 10th, 1913, our Secretary received the following communication from the Secretary of the M. C. B. Association:

Chicago, January 10th, 1913.

Mr. J. B. Anderson, Secretary, The Railway Club of Pittsburgh, 207 Penna. Station, Pittsburgh.

Dear Sir:—At a meeting of the Arbitration Committee held here January 8th, a recommendation was made, which met with the approval of the Committee, that after

the different Clubs have agreed upon their suggestions as to changes in the Rules of Interchange, that a Committee of three members from each Club be named to meet at some convenient point and discuss collectively the suggestions made by all the Clubs, so that when the proposed changes are submitted to the Arbitration Committee they will, as nearly as possible, have the approval of all the Clubs, and there will be no duplication of suggestions.

Heretofore, there have been suggestions made by different Clubs which varied only slightly, while others were more radical, and it was thought by this joint meeting, if your representatives were given some latitude in reference to changing the suggestions, that the resultant changes proposed would be in better shape for consideration by the Committee.

If this suggestion meets with approval of your Club, and you will name a Committee, I will arrange to call the meeting some time between the 1st and 15th of April.

I would suggest either Pittsburgh or Chicago as a central point for the meeting. Please express your preference.

Another suggestion made at the meeting on the 9th inst. was that when any changes are proposed in any of the rules, the reasons for such changes should immediately follow same in your report to the Committee.

Yours truly,

(Signed) JOS. W. TAYLOR,
Secretary.

This communication was referred to the Chairman of your Standing Committee on the Rules of Interchange, and the following reply suggested, which was approved by your Executive Committee:

"Your letter of January 10, 1913, suggesting that each Railway Club appoint a Committee of three to meet at some convenient point to discuss collectively the suggestions for changes in the M. C. B. Code of Interchange Rules made by the various Railway Clubs, so that the Arbitration Committee may have the recommendations before them in concrete form and eliminate contradictory recommendations, has been referred to our Executive Committee and meets

with their unanimous approval; but they feel that the recommendations should be made on a basis of the number of cars represented in each Club and that the determination of the revisions in the general meeting of representatives from each Railway Club should be on the same basis. In other words, the changes in the Rules of Interchange should be made on a basis of the number of cars represented, the same as is now done in the Revision of the Standards and Recommended Practices of the Association. This is the only equitable basis, and, if desired, the suggestions for changes, as revised by this Committee, could be presented to the Arbitration Committee with the number of car votes in the affirmative and negative.

To carry this out it will be necessary for each railroad desiring to participate to turn over to one Railway Club their car votes, so that there will be no duplication. It should also be the understanding that such action on the part of any railroad does not prevent it dissenting from any recommendation made by the Joint Committee should the same be deemed undesirable. The opportunity for such action will be afforded any Railway Company by the Arbitration Committee at the meeting at the Convention preceding the consideration of the report of the Arbitration Committee.

We will arrange to appoint a Committee of Three to present our recommendations at a meeting in joint conference with representatives from other Railway Clubs any time after April 1st, and would suggest that Chicago be selected as the place for the meeting."

Your Committee proceeded to elect among themselves the three members who were to represent The Railway Club of Pittsburgh in the joint meeting of representatives of the various Railway Clubs, and as a result the following were chosen, subject to your approval and confirmation by the Executive Committee.

R. L. KLEINE, *Chairman.*
SAMUEL LYNN,
S. A. CROMWELL,
or
F. H. STARK.

MR. McFEATTERS: With the understanding that this Committee will have authority to make any changes they see fit, in order to co-operate with the other Railway Club Committees when the joint meeting convenes, I move that the action of the Executive Committeee and recommendation of the Standing Committee be approved, and also the appointment of the Sub-Committee, and that this Committee be given full power to act for the Club. Agreed to.

MR. KLEINE: There is a reply to the letter referred to above from the Secretary of the M. C. B. Association which reads as follows:

"Chicago, March 1, 1913.

"Mr. J. B. Anderson, Secretary, The Railway Club of Pittsburgh, 207 Penna. Station, Pittsburgh:

"Dear Sir:—I have your letter of February 26th and note with pleasure that you will name a Committee to consider collectively the suggested changes in the rules of interchange before they are sent to the Arbitration Committee; also that your vote is for Chicago as a meeting place. I will advise you definitely later on as to how the vote of the Clubs stand on the meeting place.

"In regard to the recommendations being made on the basis of cars, I question whether we could get any large number of the roads whose officers are members of The Western Railway Club to agree to the suggestion.

"At the Convention in June, the meeting at which the rules will be considered, will be made an official session of the Convention. It may be possible to carry out the idea then, but I am rather inclined to think that if such a ballot were to be taken, they would prefer to have it in the shape of a letter ballot, which would result in delaying their issue.

"Yours truly,

(Signed) "JOS. W. TAYLOR,
"Secretary."

The feature of the question regarding representation by car votes, I suppose, will be further discussed.

RECOMMENDED CHANGES IN M. C. B. RULES OF INTERCHANGE.

RULE NO. 2.

Add to the end of paragraph (c) "Or where lading has shifted."

Explanation: Some controversy has arisen as to whether shifted loads are included under this rule. When a load has shifted it is unsafe to go forward and does not comply with the loading rules for which the delivering company is responsible.

RULE NO. 4.

Change to read: "Defect cards shall not be required for material missing, *in fair usage,* from cars offered in interchange, etc." (No changes in remainder of rule.)

Explanation: The change covers the addition of the words "In fair usage." The present rule implies the inference that material missing in unfair usage need not be carded for.

RULE NO. 7.

Second paragraph, second line, following the word "Bill," add "And forwarded to car owner within 90 days from date when repairs are made."

Explanation: There is general complaint that the "No bill" repair cards are not being attached to the monthly bills. It is essential that the no bill repair cards be forwarded to car owner within a reasonable time, and the 90-day limit is specified with a view of correcting this irregularity.

RULE NO. 8.

Tenth line, before the word "Writing," introduce the word "Hand."

Explanation: Some repair cards accompanying bills are being written up in type, indicating that this work is being relegated to the office, thus defeating the intent of the rules. These typewritten repair cards are not found on the cars.

Thirteenth line, after the word "Charge," add "And rendered within 90 days from date when repairs are made."

Explanation: To insure repair cards reaching the car owner within a reasonable period of time.

RULE NO. 9.

M. C. B. couplers, or parts thereof, R. & R.: Add "Name" in brackets.

Explanation: This is essential so as to enable proper charges and credits to be made where couplers of the same make or different makes are removed and replaced.

Triple Valve, R. & R. Kind. Substitute for kind the words "Make and Type."

Explanation: To provide for proper information on repair cards for billing as well as checking wrong repairs in case another type or make of valve is substituted for the one standard to the car.

RULE NO. 10.

Second paragraph, change to read: "In all cases of forged or rolled steel wheels, the actual thickness of tread before and after turning off must be shown as determined by gauge, as per M. C. B. Recommended Practice Sheet C-1; also show actual thickness of tread on other wheels applied. This information must be reported, etc."

Explanation: The basis for measurement of thickness of tread should be on a full flange contour. The gauge adopted last year enables the road changing the wheels to determine the thickness of tread based upon a full flange contour before turning, thus enabling the handling of this matter equitably.

RULE NO. 13.

Substitute the following for present rule 13: "The joint evidence card shall be sent to the company against which the evidence has been presented to investigate and furnish defect card covering the wrong repairs, if it made them."

Explanation: The provision that joint evidence shall be authority for bill is unsatisfactory in cases where wrong repairs were previously covered by defect card, but overlooked when joint evidence was obtained, consequently resulting in duplication of bills. In some cases owners render bills for wrong repairs not covered by repair card on the car. It is also necessary for the car owners to retain the repair card in their file according to Interstate Commerce Commission requirements.

RULE NO. 14.

Add to end of Rule 14, Page 16, "Or in card holder if car is so equipped."

Explanation: On account of the impracticability of attaching card boards to some cars, they have been equipped with card holders, and in order that they may be included in the provisions of the rule, this recommendation is made.

RULE NO. 17.

Add after the fifth paragraph the following: "Cars built after September 1st, 1913, not equipped with either No. 1 or No. 2 brake beams will not be accepted in interchange."

Explanation: The M. C. B. Association has adopted a standard for No. 1 and No. 2 brake beams with a view of providing a brake beam of suitable strength and facilitating repairs on cars offered in interchange. Some roads are disregarding these standards and applying brake beams of inadequate strength. The above recommendation is made with a view of enforcing this essential standard of the Association.

RULE NO. 20.

Omit first paragraph on page 18, as this provision is covered in second paragraph at the top of page 19.

RULE NO. 28.

Change last two lines to read: "Not stencilled showing the capacity, or maximum weight, or limit weight I. or limit Weight II."

Explanation: To provide proper reference to the limit weights for tank cars.

RULE NO. 36.

Add new rule as follows:

> "*Test of Safety Valves on Tank Cars*: All safety valves of tank cars must be tested and adjusted, if necessary, by January 1, 1914.
>
> "Safety valves on ordinary tank cars must be tested and adjusted, if necessary, at intervals of not over two years.
>
> "Safety valves on special tank cars, for carrying volatile, inflammable products, with a vapor tension of over ten

pounds per square inch at a temperature of 100 degrees F., must be tested and adjusted, if necessary, at intervals of not over six months.

"The pressure and date of the last test must be plainly stenciled on the body of the valve, as follows:

Tested (date) ....

Pressure (pounds per square inch)..........

At (place) ....

By (name) ....

(Test to be made and pressures used as provided for in the M. C. B. specifications for tank cars, revised in 1912.)

"Valves improperly set, or not tested and stenciled at proper intervals, shall constitute defects for which car owner shall be responsible."

Explanation: To provide for the proper maintenance of the safety valves on tank cars as required by the M. C. B. Specifications for Tank Cars and the Regulation of the Interstate Commerce Commission.

Combinations of Damages.

The present combinations of damages for wooden underframe cars are unsatisfactory, as the existing rules are resulting in partial repairs being made to wooden underframe cars to avoid the combinations, or delays occasioned to obtain the owner's authority for repairs to owner's defects or damaged parts, which, if repaired without the owner's consent, would result in the refusal of the bills. Where complete and proper repairs are not made, it directly affects the safety of the car, for which reasons the following changes are recommended:

HEADING.

Change to read: *Combinations of Damages to Cars With Wooden Underframes Which Denote Unfair Usage, if Existing at the Same End of Car and Requiring Repairs or Renewals."*

Rules Nos. 37, 38, 39 and 40: Eliminate these rules from the combinations.

Rule No. 42: Eliminate first two foot-notes in small type and add new footnote as follows: "Coupler or coupler pocket will not enter into the combinations."

Composite Wood and Metal Underframe.

To take care of the composite wood and metal underframes a new rule is recommended as follows:

HEADING.

"Combinations of Damages to Cars with Composite Wooden Underframe and Continuous Metal Draft Sills, which may be made up of one or more sections extending from end sill to end sill.

New Rule: Damaged end sills and longitudinal sills, if necessitating replacement, splicing or straightening of more than one end sill and two longitudinal sills. Delivering company responsible.

Note: "Coupler or coupler pocket will not enter into the combination."

All Steel or All Steel Underframe Cars.

Experience has demonstrated that the combinations of damages to wooden underframe cars cannot be consistently applied to all steel underframes on account of the difference in construction. The present rules are unsatisfactory, as they do not cover cars of weak construction which are failing in ordinary service. The changes in the rules recommended below make the handling road responsible for all repairs necessitated by unfair usage, derailment or accident. The car owner is held responsible for failure due to ordinary wear and tear, corrosion and weak construction. Insofar as weak construction is concerned, the new rules presupposes that where a car has not been in accident and the repairs do not exceed the splicing or renewal of two center sills and an end sill, that the construction of the car failed to withstand the ordinary service requirements; where the damage exceeds this amount the delivering company is responsible unless it takes the matter up with the car owner and obtains his consent for the repairs necessary on account of weak construction or corrosion.

RULE NO. 43.

Damage to bodies of all-steel cars, or damage to underframe of all-steel underframe cars, when necessary to repair, if caused by unfair usage, derailment or accident. (Delivering company responsible.)

Longitudinal sills, end sills and other steel parts of cars which become defective due to corrosion, or weak construction and which were not damaged in accident or by unfair usage. (Owner responsible.)

Where repairs exceed straightening, splicing or renewal of two center sills and one end sill authority for repairs must first be obtained from the owner.

RULE NO. 44.

Add to end of first paragraph: "Or where lading has shifted."

Explanation: To conform to change made in Rule No. 2, paragraph "C."

RULE NO. 49.

Change to read: "Steel cars not equipped with card boards or *card holders* for repair and defect cards."

Explanation: Change involves the addition of the words "card holders" to conform to change in Rule No. 14.

RULE NO. 52.

Change last paragraph to read: "On cars stenciled United States Safety Appliances Standard, or on cars stenciled United States Safety Appliances, lag screws *or nails* must not be used where bolts, rivets or screws are required by law."

Explanation: To cover the fastening of running boards as required by law.

RULE NO. 55.

Change to read: "Cars offered in interchange with missing brake beams, including shoes, heads, jaws, hangers, *bottom connections, brake levers, brake shoe keys, key bolts and brake hanger pins,* when missing with the brake beam. (Delivering company responsible for material, car owner responsible for labor)."

Explanation: The delivering company should be responsible for the items added, viz: bottom connections, brake levers, brake shoe keys, key bolts and brake hanger pins, as well as for the items now enumerated, when lost with the beam, as these additional items are frequently missing when the beam is lost.

RULE NO. 57.

Consolidate with Rule No. 59 and revise as follows, in order to more clearly set forth the delivering road and the owners' responsibility:

Delivering Company Responsible.	Missing air brake hose, missing or damaged cylinders, reservoirs, triple valves, angle cocks, cut out cocks, brake pipe strainers or dirt collectors, pressure retaining valves, release valves, pipe, pipe fittings, or any parts of these items, except as follows:
Owners Responsible.	Air brake hose burst, torn or worn out; air hose labels, illegible or missing from wear; air hose couplings that become defective in fair usage; release valve rods defective or missing; leaky pipe or pipe fittings, account of rust or seams; broken pipe or pipe fittings; broken lugs on brake cylinders or reservoirs, account insecure fastenings; or damage to interior parts of cylinder or triple valve, under fair usage. Also failure or loss under fair usage of other parts of brakes, or if any part of the brake rigging is less than 2½ inches above the top of the rail.

RULE NO. 58.

Change to read:

Delivering Company Responsible.	"Cars equipped with air brake hose other than M. C. B. 1⅜ inch standard and labeled as per cut shown on either pages 36 or 37." "After September 1st, 1915, hose not labeled as per cut on page 37."

Explanation: The first note below Rule No. 58 may be omitted after September 1, 1913, as air hose showing application or date of manufacture prior to September 1, 1909, are no longer in service.

The second note to be changed as indicated above, as the label in question is now a standard of the M. C. B. Association. It will be noted that the time limit for air brake hose label complying with this new M. C. B. standard has been extended one year, as September 1st, 1914, does not allow sufficient time to work off the hose having label standard prior to adoption of new label.

RULE NO. 65.

Remove from bracket and change to read: "Journal bearings and journal box bolts which require renewal by reason of

change of wheels or axles, shall be charged against road responsible for change of wheels or axles."

Explanation: At present this rule is not clear, as it only covers the charging of the renewal of box bolts and bearings against the delivering line, whereas it is the intention and practice, and is covered by arbitration decisions, to charge the renewal of journal box bolts and bearings against the road responsible for the change of wheels or axles.

RULE NO. 68.

Add after the word "Length" in third line "And for the mate wheels, if the spot caused by sliding is two inches and over in length."

Explanation: A wheel with a flat spot two inches or over in length is not fit for remounting and results in a loss to the party applying wheels on defect cards.

RULE NO. 69.

Change the word "Throat" to "Either" in second line and omit Rule No. 82.

Explanation: Chipped flanges ordinarily do not occur in fair service; they are caused either by allowing flanges to strike together before wheels are applied, or are the result of irregular track conditions, and, therefore, it is recommended that the delivering company be made responsible for all cases of chipped flanges.

RULE NO. 86.

Add the 6"x11" journal to this rule.

For Cars Marked With Capacity.

Capacity of Car.	Journal.	Wheel Seat.	Center.
140,000	5½"	7⅜"	6 7/16"

For Cars Marked Maximum Weight.

Maximum Weight	Journal.	Wheel Seat.	Center.
210,000	5½"	7⅜"	6 7/16"

TABLE I.

For Tank Cars Marked Limit Weight I.

Limit Weight I. in Lbs.	Journal.	Wheel Seat.	Center.
210,000	5½"	7⅜"	6 7/16"

For Tank Cars Marked Limit Weight II.

Limit Weight II. in Lbs.	Journal.	Wheel Seat.	Center.
210,000	$5\frac{1}{2}''$	$7\frac{3}{8}''$	$6\ 7/16''$

Explanation: Quite a number of these axles are now in service and it is essential that there should be limiting dimensions for the same.

RULE NO. 94.

Add to the end of Rule: "Except for defects on cars of 60,000 pounds capacity and over, which are destroyed instead of repaired."

Explanation: When the damage on certain cars exceeds a stipulated amount, car owners have decided to tear down instead of repair, and replace with more modern equipment. In cases of this kind a car owner should have the right to bill on the defect cards for the damage done, as this was primarily the cause for replacing the cars.

RULE NO. 98.

Page 58, paragraph under Delivering Line Defects, third line, substitute the word "And" for the words "But no."

Explanation: The owner of cars having forged or rolled steel wheels is benefited when service metal on wheels is increased.

Page 59, first paragraph under Delivering Line Defects, 17th line, place a period after the word "Owner" and omit remainder of paragraph.

Explanation: The owner being benefited by the increase in service metal it is but equitable that he should be willing to pay for the same.

RULE NO. 100.

Second paragraph, change to conform to modification made in Rule No. 10.

RULE NO. 101.

Add new items as follows:

One new M. C. B. No. 1 brake beam, $3.25.
One new M. C. B. No. 2 brake beam, 4.25.

Explanation: Inasmuch as the Association has now established Standard No. 1 and No. 2 brake beams, and Rule 17 pro-

vides that it is permissible to apply standard M. C. B. brake beams, provided no change in hangers or other details is required, it is felt that the prices should be incorporated in the rules for these No. 1 and No. 2 brake beams.

RULE NO. 104.

Page 65, change last three lines to read: "New, and similarly the credits for metal brake beams must be seventy-five per cent of the prices when new for standard No. 1 or No. 2 M. C. B. brake beams and scrap credit for beams not M. C. B. standard."

Explanation: The present credit of 50% for M. C. B. standard brake beams is inadequate and should be 75% of the value when new. Beams not conforming to the M. C. B. standards for No. 1 or No. 2 brake beams should be credited as scrap.

RULE NO. 105.

Change to read: "Including freight charges."

Explanation: The road making the repairs should not be penalized by being compelled to absorb the freight charges, as this is a proper charge against the car owner.

RULE NO. 107.

Change the word "Replaced" to read "Renewed" throughout the rule, wherever applicable.

Explanation: The word replaced when used to mean renewed is misleading. Example: Page 74, "Replacing truck spring, when out of place, empty car, 1/4 hour;" here the term replacing is used correctly. Page 78, "Truck springs, one or all, in same truck, replacing, 2 hours," in this case the word replacing is incorrectly used and should read renewing.

Page 69, omit 8th, 9th and 10th items and place note under draft timber bolts, same page, as follows: "Carrier iron bolts which pass through draft timbers or draft arms will be considered as draft timber bolts. Bolts for supporting coupler carrier irons to be charged under length of bolt."

Explanation: There is considerable confusion in connection with making charges for bolts which pass through draft timbers and at the same time support coupler carrier iron. The revision above suggested will simplify the whole proposition and is along the same principle as center plate bolts.

Pages 72 and 73. End Planks, change the four items on end planks as follows:

End plank on gondola cars, renewed:

Without corner bands, one plank, 2 hours.

Without corner bands, each additional plank, ½ hour.

With corner bands, bolted, one plank, 3 hours.

With corner bands, bolted, each additional plank, 1½ hours.

With corner bands, riveted, one plank, 5 hours.

With corner bands, riveted, each additional plank, 2 hours.

Explanation: The present prices for end planks are incorrect. In revising same we would suggest that it be done on the same basis as side plank, which is simpler and more comprehensive.

Page 78, last item, add: "This includes removing the ice from refrigerator cars when necessary to apply draft bolts."

Explanation: This should be included the same as any other commodity when necessary to remove to make repairs.

RULE NO. 109.

Second paragraph to read: "When one or more carrier iron bolts which pass through draft timbers or draft arms are replaced, where pocket coupler, etc."

Explanation: To conform to change made in Rule No. 107.

RULE NO. 116.

Page 90, omit third paragraph having reference to the addition of 10% to the prices of car bodies of cars other than gondola 60,000 lbs. capacity and over.

Explanation: These care are now of obsolete design and the addition of 10% to the value of car bodies should be dropped.

Pages 90 and 91, paragraph relating to $40.00 per car to be added to value of car bodies when equipped with metal body bolsters. Omit reference to journal size.

Explanation: The journal size should have no bearing on the allowance for metal body bolster.

RULE NO. 120.

Change to read: "A car unsafe to load on account of general worn-out condition, due to age, decay or *corrosion,* shall be

reported to its owner, who must be advised of all existing defects. If the owner elects to have it sent home, he shall furnish *four* home cards, noting upon them existing defects. Cars to be returned home *over the shortest route. Car owners responsible for temporary or partial repairs necessary to make car safe for movement. Where there is direct connection between handling road and car owner, home route cards are not required, except in cases where it is necessary to make temporary or partial repairs.*

Of the four cards furnished, one is to be retained by the forwarding road, one for manifesting purposes and the other two to be attached one to each side of the car. The cards are to be *light green in color* and of the form shown on page 107. They shall be printed on both sides, and shall be filled in on both sides with ink or black indellible pencil.

Explanation: There is a good deal of controversy and delay in sending cars home on home route cards and the above recommendation is made with a view of eliminating differences of opinion concerning the proper method of handling.

RULE NO. 122.

Fourth paragraph should follow the first sentence of first paragraph and be inserted after the word "lines" in fourth line.

Explanation: The paragraph is misplaced and confuses meaning.

Add to the fourth paragraph the following: "Shipment to be made to the point designated by the line or company ordering the material."

Explanation: This is not always done at the present time.

Page 98—Form—Authority for Transfer or Adjustment of Lading.

Line to be added to left of "Inspector" at bottom of card to provide place for signature of Inspector.

Page 99—Form—Defect Card.

Change last sentence of the printed note to read: "Attach this card to the proper designated point on the car."

Explanation: To provide for the change made in Rule No. 14.

Prices for Labor and Material.

As stated in the beginning of report of your Committee, the Circular of Inquiry from the M. C. B. Committee on Prices

for Labor and Material was received too late to work up any detail data with which to reply to this circular, your Committee, however, considered the circular carefully and has the following recommendations to make:

RULE NO. 98.

Your Committee agrees that prices for axles should be revised.

RULE NO. 101.

Your Committee concurs that the labor allowance of 24 cents per hour does not represent labor costs, but on account of lack of time to consider subject has no definite recommendations to make.

RULE NO. 107.

Your Committee would suggest voting in the affirmative as it is very essential that the hours of labor for the various items should be revised and recommends that it be done on the basis outlined in the beginning of this report.

Notes "A" to "G" under this rule to be voted as follows:

Note "A": Carrier iron bolts, increase minimum number from 3 to 5 for uniform charge. Vote—Yes.

Note "B": Draft timber bolts, increase minimum number from 3 to 5 for uniform charge. Vote—Yes.

Suggestion: Combine coupler carrier iron bolts that pass through draft timbers or draft arms with draft timber bolts and charge bolts that secure carrier iron by the piece.

Note "C": Center pin applied, price for loaded and empty car the same. Vote—No.

Note "D": Changing corner iron to corner band. Vote—Yes.

Note "E": Changing method of charging for end planks renewed by making a basis charge for one plank and one charge for each additional plank. Vote—Yes.

Note "F": Separate prices for door or side posts and corner or end posts. Vote—Yes.

Note "G": Price for removal of load at one end of car. Vote—Yes.

RULE NO. 109.

Modify Rule 109 so that coupler carrier iron bolts which

pass through draft timbers or draft arms will be considered as draft bolts. Same as recommended by your Committee in body of rules.

RULE NO. 116.

Your Committee concurs in eliminating the addition of 10% to the prices for bodies of cars other than a gondola of 60,000 pounds capacity and over. Vote—Yes.

Your Committee would recommend omitting reference to journal size in the paragraph relating to $40.00 per car to be added to value of car bodies when equipped with metal body bolsters.

Metal Sills.

	Minimum Depth of Sill 10 inches.	Depth of Sill Less than 10 inches.
No. 1	$80 00	$60 00
No. 2	100 00	80 00
No. 3	80 00	60 00
No. 4	80 00	60 00
No. 5	70 00	50 00
No. 6	80 00	60 00
No. 7	80 00	60 00
No. 8	60 00	40 00
No. 9	70 00	50 00
No. 10	60 00	40 00
No. 11	60 00	40 00
No. 12	50 00	40 00
No. 13	60 00	40 00
No. 14	40 00	40 00
*No. 15	60 00	40 00
No. 16	40 00	40 00
No. 17	50 00	40 00
*No. 18	70 00	50 00

Note: Items Nos. 15 and 18.

Built up structure, minimum depth of sill 10 inches, with top and bottom cover plates riveted and steel side wing bolsters . . . .$ 80 00

Built up structure, minimum depth of sill 12 inches, with top and bottom cover plates riveted, without steel side wing bolsters 100 00

Explanation: The above corrections were made with the understanding that Figures 1 to 10 inclusive carry with them steel center sills integral with bolster. This is only specified for Figues 1, 6 and 7, but the same should also apply to the other figures, otherwise no provision would be made for bolster. Diagram 7 does not show a top cover plate, but the wording under the figure specifies top plate. Apparently these sketches were gotten up in a hurry and not properly covered.

RULE NO. 117.

Your Committee has not had the opportunity to work up this data.

RULE NO. 118.

Your Committee has not had the opportunity to work up this data.

PAGE 36.

Average credit price for wheels. Your Committee would recommend voting Vote-Yes.

PAGE 37.

Settlement price for steel car bodies, when destroyed, on a pound basis on the original weight of car body when built. Your Committee approves this recommendation. Vote—Yes.

In concluding this report your Committee desires to express to the Club their thanks and appreciation for the arrangements and entertainment during their stay in Pittsburgh.

C. E. BOYER,
Penna. Railroad Lines East of Pgh.
G. E. CARSON,
N. Y. C. & H. R. Railroad.
S. A. CROMWELL,
B. & O. Railroad.
F. W. DICKINSON,
B. & L. E. Railroad.
G. N. DOW,
New York Central Lines.
W. J. KNOX,
B. R. & P. Railroad.
S. LYNN,
P. & L. E. Railroad.

F. M. McNULTY,
Monongahela Connecting R. R.
O. J. PARKS,
P. F. W. & C. Railway.
J. B. SWANN,
P. C. C. & St. L. Railway.
F. H. STARK,
Moutour Railroad.
R. L. KLEINE, Chairman,
Penna. Railroad Lines East of Pgh.

March 11th, 1913.

Each of the foregoing rules and recommendations were separately considered and approved without discussion, except the following:

Combinations of Damages: Rule No. 42.

MR. G. C. WALTHER: I cannot understand the necessity for that foot note. If 37, 38 and 39 were eliminated the coupler combination does not enter into the combination at all, as I understand it.

MR. KLEINE: There is no real necessity for the foot note, except in an explanatory way. The committee thought it would be well to leave it in for the present, inasmuch as the coupler has always entered into the combination and it is simply to clear up the inspector's mind as to exactly what is intended.

PRESIDENT: Is there any objection to the change as suggested? If not, we will proceed.

All Steel and All Steel Underframe Cars: Rule No. 43.

PRESIDENT: Have you anything to say on that rule, Mr. Stucki?

MR. A. STUCKI: I think it would be better to say *one* end sill instead of *an* end sill. Isn't that the meaning?

MR. KLEINE: I would like to know what you have to say about the proposed rule in relation to culling out the weak construction cars by this rule. We will make the change of *an* to *one*.

MR. STUCKI: I have nothing to say. I think it is well worked out, especially since it takes care of the question of corrosion. I might ask, though, whether it will not delay the game

where you have to get permission of the car owner before going ahead?

MR. KLEINE: It does delay the repairs to the car. But the trouble at the present time is this: The Arbitration Committee has ruled on certain steel cars, which under the present rules are treated under the wooden car combination, and held the delivering company or the handling company responsible for damage to those cars. Since that time those very cars have been ruled off some of the railroads on account of their weak structure, showing that the cars were not strong enough to stand ordinary service. They are buckling out at the sides, and, according to the Arbitration Committee's decision, the handling road is responsible for those very cars. We will never get rid of taking up certain questions with the car owner, and we feel that repairs should be made to steel cars up to two center sills and one end sill, without obtaining the authority of the car owner; in other words, the steel car should be able to withstand service conditions without the failure of two center sills and one end sill. If it fails, we feel that the handling road should have the authority to go ahead and repair the car to the amount specified without first taking it up with the car owner. Of course, it would be well if we could have fixed cross-sectional areas and other requirements in regard to strength. But I feel that that is a step in advance. We have an M. C. B. committee now working on specifications for new cars.

MR. STUCKI: I am glad to hear that last remark, because a minimum cross section is most essential and is bound to come. If we do not do it now we will have to later.

PRESIDENT: Is there any objection to the report of the Committee as read, except as to the one word which has been changed? If not, we will proceed.

Rule No. 57.

MR. WALTHER: There is one item in the fifth line where it says "leaky pipe or pipe fittings, account of rust or seams," and the next is "broken pipe or pipe fittings." Does that take in all the broken pipe and pipe fittings regardless of rust or seams?

MR. KLEINE: All broken pipe and pipe fittings that have not been damaged by unfair usage. It is very hard at the presnet time, as you know, to differentiate between pipe that has

been broken due to rust and where the thread has been cut off to one side and it breaks through on that account, and for that reason the Committee thought it would be well to place it under Owners' Responsibility and get out some of the leaks in our present train lines.

MR. WALTHER: I only raised the question because in the paragraph above it says rust or seams in reference to leaky pipes, and makes no mention of the rust or seams in the broken pipe. That is what I was trying to get at.

MR. KLEINE: We added the broken pipe in addition to the leaky pipe due to rust and seams so as to clearly define owner's responsibility for both rusty pipe and broken pipe; if it is damaged by unfair usage that is another matter.

(Note Changes in prices of metal sills in Rule No. 116.)

PRESIDENT: Are there any questions to be asked or suggestions or amendments to be offered in relation to any of the rules not covered by the Committee? If so, we would be glad to hear from them now. Or are there any questions to be asked by any one relative to the report of the Committee as presented? If not, I will entertain a motion to adopt the report of the Committee as a whole, and the recommendations therein contained.

MR. STUCKI: This is the most harmonious meeting I ever experienced. Mr. Kleine and his Committee must be mind-readers, or else the Club has a great deal of confidence in them.

PRESIDENT: You will observe in the notice of this meeting that a discussion will be brought up on the feasibility of welding truck bolsters, truck sides and other car castings. Some of the gentlemen whom we expected to be here are not present, but if there is anyone who will speak on this subject, we will be glad to hear him now.

MR. McFEATTERS: How about Mr. Stucki?

MR. A. STUCKI: I do not like to talk so often and say so little. But in regard to welding: With the oxy-acetylene flame the most important point is to decide whether or not to use this process. In a great many cases it makes a most excellent job; in other cases it should not be tolerated. If we have

bolsters or any other castings with unimportant imperfections, the oxy-acetylene or electricity will enable us to weld such places and fill imperfections, so that the casting is fully as effective as if it had been cast completely in the first place. But when we come to weld dangerous places, where the material is strained to a maximum, welding by electricity, oxy-acetylene or thermit is a dangerous proposition.

It is really not a welding but a fusing of the metals, whereby we are changing the structure of the original material near the weld. Of course, often a great deal of time and money can be saved in making a local "weld" without dismantling. Such jobs, however, come usually under the head of temporary repairs. Again, if a part is subjected to high tension, say a brake rod as an extreme case, nobody would think of welding it by that process.

MR. F. H. STARK: We all recognize Mr. Stucki as being authority on almost everything, but I would like to ask him why it would not be permissible to weld a brake rod if we add enough additional material, increasing it over the original diameter of the bar, and then drawing it out, whether that would not be just as strong a weld as one made by the old-fashioned way. We sometimes get a false notion that a pair of shoes made by hand is better than one sewed on a machine, but that is not true. The practice of welding by electricity and acetylene has developed very rapidly within the last two years. The competition is so keen that prices are going down by leaps and bounds, so that a company recently organized have proposed to put in a plant for nothing, so that everyone will be able to have facilities for welding, and there is no question that it is going to result in great saving, especially in connection with boiler work. Repairs can be made in a few hours that ordinarily would cost scores of dollars.

MR. STUCKI: I think Mr. Stark has answered the question himself. Welding a rod and adding material and swedging it down is all right, because the material is being worked just the same as with the old-fashioned weld. I had reference to electric or oxy-acetylene welding alone, without working the material afterwards. In regard to the cost of appliance for doing the work, we may get it for nearly nothing, but we pay for the acetylene or the prestolite possibly 2¼c, while if we could install

a plant, we could make it possibly for .8c. That is where the other fellow makes his money, so he does not suffer

PRESIDENT: Mr. A. W. Whiteford, Mechanical Engineer for the Oxweld R. R. Service Co., is here at our invitation, and we would like to hear from him.

MR. WHITEFORD: Mr. President and Gentlemen—I am very sorry I arrived so late, as I would much rather have been here from the beginning of the meeting, but on account of the high water we have been about twenty-eight hours getting here from Buffalo, so I will have to ask you to overlook us this time, and we will try and do better in the future. I have never before had the pleasure of meeting with The Railway Club of Pittsburgh, although I have often heard of you and have often read over your proceedings.

I have come here in response to an invitation from your Secretary to say what I can in regard to the welding up of broken car castings, side frame bolsters, etc., by the oxy-acetylene process. I am an ex-railroad man myself, but am now connected with the Oxweld R. R. Service Co., and as we are very much interested at present in all kinds of oxy-acetylene work, I thought I might be able to tell you some few things of interest, or perhaps answer a few questions in regard to the application of this process to car work.

To begin with, I want to say first of all that there is nothing hidden or mysterious about the art of working metals with oxy-acetylene. The science of autogoneous welding is not a vague indefinite something that hovers around here and there in various stages of undefinable haziness, bestowing its favors only when and where it would seem to choose. It is, in fact, very simple to understand and quite easy to apply. Even in the fullness of its development, however, it must not be imagined that its power is unlimited. It is no Aladdin's Lamp, that smooths out all the rough spots by the simple fact of its possession. We cannot take a torch, as some overly enthusiastic salesmen might try to make us believe, wave it through the air like a magic wand and then see all our trials and troubles disappear. Far from it. The oxy-acetylene process, as it appeals to me, is nothing more or less than an improved method of doing certain kinds of work with which we have long been familiar.

The simple possession of a tool does not mean its successful

operation. With any kind of a tool we have to use our brains and our judgement and our mechanical ingenuity, or else the tool will not fill the requirements for which it was designed. You may have the finest lathe in the world, but you could never make a fit on it, if the workman who was running it did not understand how to use a pair of calipers.

Oxy-acetylene outfits are valuable adjuncts to any shop or car yard. In fact, they are rapidly becoming almost indispensable. It is getting to be nearly impossible in many places to get along without them, and yet they are nothing more nor less than a handy, convenient, flexible tool, whereby certain kinds and classes of work can be done quicker and cheaper and more efficiently than previous practices have made possible.

The original beginning of the process we owe to the French or the Belgians. The successful development of the art we owe to the Germans. Like many other things, its development has been a sort of an evolution. Oxy-hydric blow pipes have been used by chemists practically since chemistry first became a science. This was the original forerunner of the oxy-acetylene burner. Acetylene gas was known as long ago as 1836, and oxygen has been known as a life-giving element for generations.

The success of the art has rested almost entirely on the development of its application to practical work. The oxygen that the chemists knew originally was expensive and hard to get. The same was true of acetylene. It was as late as 1892 before acetylene gas was really a commercial possibility. As we know it today, it is made from calcium carbide and water. Calcium carbide is the metal found in lime rock united in proper proportions with a low ash coke, and this combination is made possible by means of the modern electric furnace.

Oxygen can be produced in various ways. The proper combination of scrap iron and sulphuric or nitric acid will produce some of it. It can be bleached out in a retort if the proper combination of potassium chlorate and dioxide of manganese are first thrown together. It can be taken from water by means of an electric current, or it can be taken directly out of the air by what is known as the Linde process. With the proper combination of these two gases in a blow pipe or burner, it is possible to create a flame with a temperature of about 7000 degrees of heat.

This will melt any known metallic substance or any combination of metallic substances and cause them to flow together.

Cutting metal by the oxy-acetylene process consists in applying a jet of pure oxygen directly to the point where the separation is to take place. This jet varies in volume and pressure in accordance with the thickness of the metal to be cut and it is in all cases surrounded with or accompanied by a pre-heating flame, which consists of a properly mixed jet of oxygen and acetylene, the object of this pre-heating flame being to soften the metal and thereby aid the oxygen in its work.

Oxy-acetylene *welding* consists in the flowing together or the building up together of the basic properties of the metal which is being worked on. The success of a weld depends on several things, among which are the cleanliness of the pre-heating gas. Most of all, however, and above all the rest, is the skill of the operator and his knowledge of metals. If the operator understands what he is doing, it is almost impossible to fail. Special designs or types of torches have nothing to do with the making or the failure of a weld. They are simply an arrangement put in the hands of the operator for the applying of the heat.

The amount of time taken, the amount of gas used, the cost, and the general service of the work may vary, of course, with the type and design of the torch, as the pressure at which the gas is applied and various other features that go into some of the technical points of the art, have a bearing on these features, but the fact as to whether or not a weld holds or fails depends on the operator just as much as the fit of a nut on a bolt depends on the man who pulls it up or the clinching of a nail depends on the man who drives it. It doesn't change the nail any nor the wood that it enters, but it often makes a difference as to who swings the hammer, or rather how the hammer is swung. The make of the nail and the holding power of the wood are other and entirely separate features.

In oxy-acetylene welding the skill and ability of the operator depends on his knowledge, because, as I said a moment ago, he has in the torch only the means of applying the heat. With the oxy-acetylene flame he works the material into a running state exactly as though it were in a retort, and then builds into that flowing mass the necessary elements that are required to fill in where the crack or break may be. If he gets the flow absolutely

uniform between the metal he is applying and the metal to which it is being applied, he cannot fail to make a weld. He will fail, however, if he has the body heated to a different temperature from the metal he is filling into it, or vice versa. It is not a casting process, it is not a soldering process, it is not a brazing process, it is not a building-over process. It is an actual flowing together of the basic elements of the materials on which the work is being done. If it is cast iron that is being worked, there are certain rules to observe in regard to the heating, in regard to the method of application and to the cooling-off process after it is applied. There are different things to watch if it is a steel casting. There are still different things to watch if it is a boiler plate, or a piece of aluminum, or a piece of bell metal, or whatever it happens to be. In any or all of them, however, a failure is usually due to the fact that it was not properly handled when being worked.

I am a Pennsylvanian born and bred, and may be patriotic enough not to want to admit it, but from all we can learn we seem to be about six or seven years behind the Germans in oxy-acetylene welding. We find on the other side that the development of the art has reached such a state that the German government has organized special departments in institutions of learning similar to our State schools, where the art is taught. There are, in fact, entire trades in Germany that do practically all their work with oxy-acetylene equipment. They are in some cases over there using pipe about half the thickness we are using in America, because they do away with the threading. They use pipe which is the thickness of our pipe at the base of the thread and weld the pipe together. It is just as strong and more flexible. The Railway Age-Gazette of March 14th has an interesting article on this phase of the subejct.

When I was in the railroad business, about six years ago, I read an article or two on oxy-acetylene welding, and I took it up with our superintendent of motive power and asked permission to go into it, and he told me to get all the information I could. Information in this line was pretty scarce in these days, but after about two years of investigation, and backed up with all the information I could gather, I was allowed to get an oxy-acetylene plant. We obtained a portable plant and put it in the shop and in time we did quite an amount of work there. That

plant is still in existence in that shop, and I do not think they would give it up if they could not replace it. In the car work they never think of scrapping a Bettendorf or an Andrews truck frame, no matter how bad the crack is, and as far as I know they have never lost one of them. They had one lot of 125 draw bars fractured, cracked and broken, and they restored them and put them in service, and I know of some that have been in service over 16 months. These are just samples of what they are doing which runs through my mind. I was fortunate enough on my way down here to run into a man who is foreman of the shop where I used to be, and I brought him down with me, and he may be able to tell you more about the oxy-acetylene work and what they are doing there now than I can, and coming from a railroad man, it may be a little more direct. I have a number of pictures and photographs here, and if there is anything I can tell you about the process, or any question I can answer, I would be glad to do it.

MR. K. W. RUNSER: How about welding high carbon steel? We had considerable experience trying to join together pieces of high carbon steel, and while the weld will hold all right, they will break about two or three inches from the weld. It was about 100 carbon steel.

MR. WHITEFORD: I would not be able to tell you definitely anything in regard to welding high speed tool steel, as I have never personally seen any tool steel work done with this process. In the class of steel which is used in machinery, however, I have seen considerable work. Take a slotter bar, for instance, which you know gets quite a severe shock in service. I know of one that was broken into four pices and four welds made in it and that is running now over two years. I can take you to another shop where there was a large punch having a gear wheel about 14" in diameter that broke into three pieces and that meant the entire shop out of commission for about three weeks if they could not replace it. They built up the broken gears and the punch is running today and has been in service for over a year. These are simply incidents to show that if the operation is properly done it will restore practically the original strength to the broken article, and if you build it up enough you can get the strength above what it was originally. There is almost no chance for failure, except through the fault of the operator. I can take

you to another place where they took out a locomotive with a returned set of tires which were down to the shop limit. It was a frosty morning, and they skidded about six flat spots on those steel tires. This meant, as a usual thing, a new set of tires, costing about $250. With the oxy-acetylene they built up the spots on those tires, and when I saw that engine it had been running the third month and was as good as ever. The chemical or technical points as to the action of oxy-acetylene on high carbon steel I cannot answer, because I have never personally seen any of that work done, but I have seen the jobs done which I have mentioned.

MR. RUNSER: Well, they did not get the catch of it. The oxygen they claimed would take the carbon out of the steel and bring it down and would not hold in hardening it.

MR. S. LYNN: I would like to ask the speaker about what number of frames he has welded, and whether he has had any failures in welded frames. We have had some little experience and the manufacturer takes the broken frames and replaces them with new frames within a certain limited time, that is, provided frames fail within a limited time. In talking with different steel manufacturers, I understand they do not favor a weld in cast steel frames for the reason that the failure was evidently due to improper design, and if it was too weak originally, the welding process would not make the frame stronger. If they are right in their argument, unless you reinforce the frame, I cannot see that we are going to make it any better by welding it, and I would like to know from the speaker what number of frames have been welded and whether he has any knowledge of any failures on the repaired frames.

MR. WHITEFORD: There is no doubt that if a steel casting or any other part of your equipment is wrong in design, welding would not do away with the trouble due to faulty design. We have found in large casting work that some of the cracks were evidently due to shrinkage cracks, and if these cracks are built up by this process, you have, of course, a stronger article than you had in the first place, because the strains have readjusted themselves and new material is applied. I have had more experience with Bettendorf frames than with Andrews, and no matter how badly they may have been damaged, when restored by the oxy-acetylene process it was always successful and many

of them have been in service ever since. Draw bars, too, which I spoke about a moment ago and which are fairly heavy and see rough service, I have known to run for many months after being welded.

MR. KLEINE: May I ask what part of the draw bar was welded, cracks in the face?

MR. WHITEFORD: Cracks on top, cracks on the side, in fact, cracks anywhere around any part of the draw bar. I have seen them welded across the top and down on the sides, and in other places, some open on the sides and some on top, wherever the fracture happened to be. It makes very little difference what part of the draw bar it is.

MR. KLEINE: I suppose you know that about 65% of draw bar failures are in the face of the coupler. The face opens up anywhere from a mere crack to 1/8".

MR. WHITEFORD: Yes, I understand, and that is one place where the oxy-acetylene process is superior to any other known process. You can cut out the bad part. With the electric process, for instance, you could only fill up, but with this process you can cut it out any way you please and flow the new metal in any way you want it. That is one great advantage of this process, its flexibility. Another thing about some of the draw bar work, you can weld them in position right on the car, without the cost of removing and replacing.

MR. KLEINE: I think it would be interesting if the gentleman would explain the difference between electric welding and the oxy-acetylene process, especially what basic metal is used.

MR. WHITEFORD: That would be too big a subject and would take entirely too long at this particular time, but I will say what I can on this. I am not a steel expert nor a graduate metallurgist, but the basic formation of all steel or iron, as I understand it, is the original pig. The filler which we use is the purest kind of Swedish iron or the nearest to the pure pig that we can get, and we attempt to build into the material the basic properties which would be required the same as it would when being worked in the original furnace. And here is the difference as I see it: The flexibility of the flame of the torch, as compared to an electric arch, is such that it allows you to get that heat

more nearly uniform in all quarters and around all parts of the piece which is being worked. The heat source is, in other words, much freer in its action, more easily controlled, and easier to handle from point to point.

MR. T. J. BORING: When you weld up these knuckles, do you have a mold to restrict the flow of the metal, or do you increase the size of the material without the contour lines?

MR. WHITEFORD: No, we work right on the piece directly; we do not need any molds, or at least we have not on any that I have ever seen.

MR. STUCKI: I notice in the collection of photographs just passed around many excellent examples of how the oxy-acetylene can be used to advantage, but there are also three cases where I would say that the process should not have been applied.

In the first place, the broken brake jaw filled in, as shown, does not hold under extreme pressure. We tried a great number of times to weld defective lugs on steel castings in a similar way, but finally gave it up.

MR. WHITEFORD: It evidently must have been fundamentally wrong in design.

MR. STUCKI: It could not have been a wrong design, because the lugs hold in solid steel.

Secondly, I am doubtful whether the filling on the face of the knuckle will last any length of time, especially if the filling is made with soft Swedish iron.

Thirdly, I noticed some bolsters welded near the center almost all the way up, starting from the bottom, or tension member. Here two mistakes have been made; first, the foundry did not take care of the shrinkage properly, and that the damage was covered up by welding, which should not have been tolerated at that place.

MR. WHITEFORD: So far as the knuckle face is concerned, I have seen teeth welded on to saw blades for sawing stone that increased the life of the saw blade over half. On the face of the knuckle you could so regulate the application that you could make it harder than the original surface. You could put in a mixture that would chill. It all depends on the mixture. I remember one case where they welded up 22 locomotive

valves and only lost two of them. They also welded up ten cracked compound cylinders, and only lost four. To insure success with cast iron, great care must be exercised in the way it is handled while being welded and the manner in which it is allowed to cool off afterward.

A VOICE: What should the operator do to prevent breaking the cylinder?

MR. WHITEFORD: In the first place, he should keep the crack horizontal while he is working on it. He ought to be sure he knows how it is heated and how it is to be cooled off after. It ought to be bricked up in a furnace or buried in heavy asbestos, so that the heat would leave it slowly and gradually.

MR. STARK: How about the flanges of a flue sheet?

MR. WHITEFORD: I have seen one 42" long on a pusher engine that was welded over a year and a half ago, and it lasted about a year. I think the day is coming, perhaps, when new sheets will be welded in without rivets. This question of cracked boiler sheets, however, I consider an unsettled one.

MR. STARK: We had one of the best men in the country do it. It did not fail where the new material was put in, but failed just adjacent to it.

MR. WHITEFORD: There was evidently something wrong with the material in the first place to cause it to crack, and it is very questionable anyhow whether or not a long vertical crack can be successfully welded. It is, in fact, open to argument whether boiler cracks of any kind should be welded in certain sections of the fire-box or boiler.

MR. STARK: Has the Government approved of it in connection with marine boilers?

MR. WHITEFORD: I have no definite information of any kind on this at present, but they have not condemned it as far as I know. They are, I believe, gathering up information on that line now.

MR. STARK: Are you welding end flues in boilers?

MR. WHITEFORD: I do not very strongly advocate the welding of flues at this stage of the game, unless you have a specially experienced operator. There is not the least doubt in my mind, however, that it can be done, and quite successfully.

PRESIDENT: We would like to hear from Mr. Thomas Lewis, General Foreman of the Lehigh Valley Railroad Shops, at Sayre, Pa.

MR. LEWIS: Mr. President and members of The Railway Club of Pittsburgh, I wish to thank you for this privilege of speaking a few words before this Club on the subject of "Acetylene Welding." This is, I am very sure, a subject of very great interest to every man engaged in railway repair work, whether it be on cars or locomotives.

About two years ago our company purchased a portable acetylene welding and cutting outfit. As the operating of this machine was entirely new to every man in our shop, an instructor was sent to us to instruct our employees. This instructor remained with us about one week, and since that time we have made our own progress, constantly adding to our list of jobs to be done.

The first department to get the benefit of welding or cutting by this process was the boiler shop. First it was a small crack in a locomotive fire-box that required welding; after that a patch; then half side sheets in the fire-box, which have proven very satisfactory, even better than the half side sheets that were formerly riveted. Now we are contemplating welding the entire fire-box, so that all seams and rivets can be eliminated from the fire-box.

The work has also extended throughout the machine shop, in welding gears and small parts in connection with the motion work. Hundreds of dollars have been saved in repairs to slotting and planing machines. Car repairs have been made by this process beyond our expectations; many Bettendorf truck side frames have been reclaimed. Also repairs have been made to the Andrews truck frames. Only the day before yesterday the foreman of the car shops sent in a lot of Bettendorf truck side frames to be straightened. One of these frames was broke in two places and had to be welded. In fact, we have reached the point where this one machine is entirely inadequate to meet more than 25% of the jobs that could be done with it.

Our method of doing this work is by placing a mechanic, at full mechanic's wages, to operate the machine; then have the part to be welded properly prepared by having all rust and dirt

removed. The operator will soon learn how to make his allowances for expansion and contraction.

Gentlemen, as the time is late and not wishing to proceed any further at this time, I thank you for your attention.

MR. McFEATTERS: I would move that the Club extend a vote of thanks to the Committee on Revision of Master Car Builders' Rules of Interchange for the work they have done for the Club. And also to Mr. Whiteford for the information given us in connection with the subject of welding.

The motion was duly put to vote and carried.

ON MOTION, Adjourned.

J. B. Anderson
Secretary.

OFFICIAL PROCEEDINGS OF

RAILWAY CLUB OF PITTSBURGH

$1.00 Per Year — 20¢ Per Copy

Vol. XII. — APRIL 25, 1913 — No. 6.

"The Effect of Changed Operating Conditions and Modern Rolling Stock on the Brake and What is Being Done to Make This Money Saving or Money Losing Apparatus as Efficient as Heretofore"

By Mr. Walter V. Turner, Chief Engineer and Mr. P. H. Donovan, Mechanical Engineer, The Westinghouse Air Brake Co., Pittsburgh.

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OFFICIAL PROCEEDINGS

OF

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D. J. REDDING............................November, 1908, to October, 1910.
F. R. McFEATTERS........................November, 1910, to October, 1912.

* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, APRIL 25th, 1913.

The meeting was called to order at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M., by the President, A. G. Mitchell.

The following gentlemen registered:

MEMBERS.

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Anderson, J. P.
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Brennan, E. J.
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Chester, C. J.
Cline, W. A.
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Cooper, F. E.
Courson, C. L.
Courtney, D. C.
Craig, E. M.
Crouch, A. W.
Cunningham, R. I.
Dalton, C. R.
Danforth, G. H.
Detwiler, U. G.
Doty, W. H.
Fitzgerald, H. M.
Forsythe, Geo. B.
Freshwater, F. H.
Funk, S. R.
Gillespie, W. J.
Gowdy, H. K.
Harner, A. J.
Harriman, H. A.
Hawkins, M. E.
Lindstrom, Chas. A.
Lobez, P. L.
Long, R. M.
Lynn, Saml.
Macfarlane, W. E.
Mitchell, A. G.
Murphy, W. J.
McCauley, Wm.
McClumpha, H. E.
McFeatters, F. R.
McGaughey, Chas.
McIntyre, G. L.
McNaight, A. H.
Neal, J. T.
Newman, L. L.
Parke, F. H.
Pehrson, A. K.
Rabold, W. E.
Redding, D. J.
Robbins, F. S.
Ross, C. B.
Ryan, Wm. F.
Salkeld, R. C.
Sargent, L. L.
Schiller, John
Searles, E. J.
Sewell, H. B.
Shallenberger, C. M.
Shremp, J. A.
Smith, M. A.
Snyder, Jos.
Snyder, J. R.
Suckfield, G. A.
Suhrie, N.
Taylor, F. C.
Thompson, C. H.
Towson, F. W.
Travis, J. H.

Hays, M. D.
Haynes, J. E.
Hilty, H. A.
Howe, H.
Hudson, W. L.
Hyde, E. L.
Jones, W. A.
Kendrick, J. P.
Krebs, G. W.
Knickerbocker, A. C.
Koch, Felix
Lehr, H. W.
Tucker, J. L.
Turner, W. V.
Voigt, A. J.
Wagner, H.
Walker, J. W.
Walter, W. A.
Walther, G. C.
Ward, R. H.
Warne, J. C.
Wills, J. F.
Wittig, Wm.
Wyke, J. W.

VISITORS.

Albert, L. H.
Allen, G. A.
Baird, E.
Beale, C. E.
Bearinger, J.
Brenton, J. E.
Brown, B. J.
Burgess, Thos. S.
Cepeda, M.
Cooper, J. H.
Cunningham, F. H.
Donaldson, H. C.
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England, A.
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Linn, Jacob
Mayhew, E. A.
Miyosaki, Y.
Moeller, L.
McCollum, Geo. C.
McCormick, J.
McCune, J. C.
McGuire, S. H.
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Osbourne, A. S.
Pauline, Jos.
Raphal, T. T.
Roberts, W. P.
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Shannon, Chas.
Siegrist, J. S.
Sleman, W. C.
Smith, G. M.
Sneck, H.
Snyder, Geo. T.
Swarknelder, R. C.
Tarr, Geo. W.
Thompson, J. D.
Trimmer, Jas. W.
Weaver, E. H.
Wendsle, N. H.
Wrenn, C. G.
Wright, John T.
Yawman, C. A.
Yohe, J. K.
Zerby, R. J.

PRESIDENT: The call of the roll will be dispensed with as the registry cards furnish the record of attendance.

The reading of the minutes of the last meeting will be dispensed with, as they are in the hands of the printer.

The Secretary read the following list of applicants for membership:

Cain, Clyde C., Chief Clerk, Firth-Sterling Steel Co., 1422 Olivery Bldg., Pittsburgh. Recommended by A. E. Barker.

Cooper, J. H., Rep., Dearborn Chemical Co., 1622 Farmers Bank Bldg., Pittsburgh. Recommended by A. W. Crouch.

Douty, C. D., Inspector, Test Dept., Penna. R. R., Barree, Pa. Recommended by John P. Neff.

Hague, Jos. R., Rep., Independent Pneumatic Tool Co., 1208 Farmers Bank Bldg., Pittsburgh. Recommended by Geo. A. Gallinger.

Moore, Chas. B., Vice-President, Oxweld R. R. Service Co., 339 Railway Exchange Bldg., Chicago, Ill. Recommended by J. B. Anderson.

Stumpf, F. L., Air Brake Inspector, Penna. R. R., Aspinwall, Pa. Recommended by T. M. Blakley.

PRESIDENT: Gentlemen, these persons whose names have been read will become members as soon as they have been approved by the Executive Committee.

The next in order will be the report of committees.

The Secretary stated he had received a report from Mr. R. L. Kleine, Chairman of the Sub-Committee on Revision of M. C. B. Rules of Interchange, composed of Mr. Samuel Lynn, Mr. S. A. Cromwell and himself, to the effect that they met in joint conference with representatives from other Railway Clubs in Chicago on April 14th. That out of 46 recommendations approved by The Railway Club of Pittsburgh at their meeting on March 28th, and which your sub-committee was instructed to bring before the joint conference, 3 were rejected, 29 approved, 3 modified and 11 referred to other committees of the M. C. B. Association.

SECRETARY: Mr. President, this report indicates that very good judgment was used by our standing committee on revision of M. C. B. rules in preparing their recommendations, and also that the sub-committee composed of Messrs. Kleine, Lynn and Cromwell, selected to represent this Club in joint confer-

ence, were the right men in the right place. The efforts put forth and the results accomplished are certainly a credit to The Railway Club of Pittsburgh. Therefore, I move that we show our appreciation of their service by a rising vote of thanks.

This was unanimously concurred in.

The Secretary then read a communication from H. C. McEldowney, Treasurer, Pittsburgh Flood Relief Committee, acknowledging a contribution of $100.00 from the Club.

President: Is there any new business?

SECRETARY: Mr. President and Members—The subject for our next meeting in May will be "Railroad Signaling," by Mr. A. H. Rudd, Signal Engineer of the Pennsylvania Railroad.

PRESIDENT: Is there any unfinished business? There being no unfinished business, the next will be the subject of the evening, entitled "The Effect of Changed Operating Conditions and Modern Rolling Stock on the Brake and What Is Being Done to Make This Money Saving or Money Losing Apparatus as Efficient as Hertofore." This will be presented by Mr. Walter V. Turner, Chief Engineer, and Mr. P. H. Donovan, Mechanical Engineer of The Westinghouse Air Brake Company.

I wish to call your attention to a new gavel, for which the Club is indebted to the Pennsylvania Railroad and the Pittsburgh & Lake Erie Railroad jointly. This is made out of a section of rail of the old Portage Railroad, which was the first railroad over the mountain, weighing 35 pounds per yard. If anyone wishes to look at it at the close of the meeting they may have that privilege.

The Effect of Changed Operating Conditions and Modern Rolling Stock on the Brake and What is Being Done to Make This Money-Saving or Money-Losing Apparatus as Efficient as Heretofore.

BY

WALTER V. TURNER,
Chief Engineer,

AND

P. H. DONOVAN,
Mechanical Engineer,

THE WESTINGHOUSE AIR BRAKE CO.

Mr. President and Fellow Members: It is rather a coincidence that this gavel should come up tonight, for it is an odd representative of the subject of the paper, that is the changes in condition. Still, I don't expect to go back as far as 1840. Nevertheless, you will find that going back only thirty years such amazing changes have taken place that it is almost beyond the conception of some who have grown right up with the business.

The subject of the paper is "The Effect of Changed Operating Conditions and Modern Rolling Stock on the Brake and What Is Being Done to Make This Money Saving or Money Losing Apparatus as Efficient as Heretofore." Now, before commencing to read, I want to say that I doubt if, outside of the locomotive, there is anything that can make more money for the railroad in certain sections of the country, and particularly in congested districts, than is true of the brake. On the other hand, I want to be equally emphatic when I state that no matter where the brake is used, whether in congested districts or not, that there is nothing that can lose more money or cause more cost than the brake, if the proper brakes are not used in the first place and not properly cared for in the second place. The reason, therefore, will be apparent to most of you when you consider the tremendous energy that has to be dissipated in stopping or controlling a train of today. You can readily see that if we attempt to suddenly dissipate, either by accident or design, such a vast store of energy, severe concussions must of necessity take place, which are damaging to lading and to equipment, as well as causing serious delay.

As an illustration of the money making power of the brake —and while this is an extreme case, I want it understood that I am not trying to impress you with the idea that in every case the brake can make or save as much money as in this particular case. In 1907 the subject of figuring the capacity of the subway in New York was broached and of course an effort made to increase it. At that time it was increased by improving the brake; strange as it may seem, they got over the road quicker by using better brakes, and I believe at that time it was the only change that was made and the capacity was increased very materially. The same thing came up in 1910 and your orator was one of those called to New York to go into the matter a little. At that time they were considering putting on larger motors in order to get a speed of sixty miles per hour instead of forty, and therefore get over the road in shorter time. That looks perfectly natural, and yet as a matter of fact under those conditions they would have actually consumed more time between stations than with conditions as they were. The reason for that is that when you double the speed of a train it takes four times the distance to stop, and in this case it would require more than twice the distance to stop; consequently, in such short runs as they have they would have made no material gain by using larger motors. Then it was suggested that they put on better brakes and stop sooner or in shorter distances. At first glance it didn't seem as though they could make much increase of capacity from this, but when it was pointed out that time saved by deceleration has a value equal to that saved by acceleration and that a much more rapid rate of deceleration was obtainable, the possibility of increased capacity was apparent. And, by the way, this more rapid rate of deceleration was obtainable by making a greater use of the potentiality of the rail. It may not have occurred to you, but the rail is the starting point for the brake. The basis of the whole matter lies with the rail, and it is only by measuring the rail capacity that we can determine the possibilities of stopping.

By a full use of the potentiality of the rail practically all the power developed in the electric plants of New York and put into these trains, could be used to much better advantage. Nearly all of the amount that was waste product, could by making more efficient stops, be made into a by-product and therefore

make a large gain to the railway company. This is how it was done. The train possesses a certain energy. That energy can be dissipated in minutes or in seconds at the will of those in charge. If you dissipate it in seconds, it is obvious that you shorten your stop; in minutes, why, you consume that very element which the railway is built to save, namely, time. With better brakes a train with the old brakes on and one with the new could leave a station together and with the cars equipped alike for power (a maximum of forty miles a hour) at the point where the old type had to apply its brakes the other one could continue to move under power for some distance, and thus the train with the new brake would be in the station to which it was going and its passengers discharged, other pasengers on the train and clear, when the train with the old type reached the stopping place. This was done, and the time of stopping was cut down to one-half of that previously required. Thus the one train was moving with the power on for 20 seconds after the other had the brake on. Also the emergency stop was cut from 650 to 350 feet, so that the signal space could be shortened, and together the capacity of the subway increased about 40 per cent per day. This shows what can be done with the brake. It cost some money to do this, but not one-twentieth of what it would have cost to have obtained the same result by other means.

Now, then, as to another phase of the question. You can imagine with such tremendous energy as we have today to cope with, that braking is an important problem; particularly when the time element is considered, which is the most important element in the air brake. There are many, even among railroad men, who fail to take this into consideration. The engineer on the engine looks at his gauge and thinks that what is taking place there is taking place in the rear, which, however, may be a long way off. He thinks what takes place on the head end takes place at the rear end at or about the same time, while, as a matter of fact, the brakes may be full set on the head end before they have commenced to apply at the rear, and on long freight trains even before the twentieth brake has commenced to apply. With these things before us, we can consider the effect of changed operating conditions and modern rolling stock on the brake and what is being done to make this money saving or money losing apparatus as efficient as heretofore.

The magnitude of the task of reviewing all the functions and factors of the air brake, in their necessary conjunction with train operation and control, in the time at our disposal will require that a large part of it be covered by rather epigrammatical statements which are open for elaboration whenever any of the members may desire.

Also, we ask you to keep in mind that improvement is often thought of years before conditions warrant its use, but when the conditions change, the folly of continuing to use the old is at least as great as would have been the folly of using the improvement when not warranted. In other words, the existence of a thing is not in itself a sufficient reason for its use, but rather the returns in safety and efficiency obtained by it.

One might state what the effect of changed conditions and rolling stock has on the operation and efficiency of the brake without mentioning what factors are involved in the make- up and operation of the brake, but your orator believes that it is far better to very briefly mention what these factors are before doing so. This for two reasons:

First—In order that we may all have a common understanding of the premises or fundamentals upon which the deductions regarding the effects are produced.

Second—Because, while we find railroad men in all other departments of railroad activities writing and discussing upon the various inter-locking and interdependent physical equipments and scientific development of the organization, I cannot call to mind any railroad man who has discoursed very much upon the subject of brakes, and from this I am led to conclude that (first) either they do not realize the tremendous importance of this wonderful safety device, or that it is the important dividend earning asset, or, (second) that the subject is too complex and involved for them to take the time to know it as thoroughly as they do other phases of their duties, or apparatus that goes to make up the physical equipment of a railroad, or, (third) that they are willing to leave all consideration of the brake equipment and train control to the air brake man, or air brake engineer, as I hope some day to hear him called, of the road.

Whatever it is, it is most surprising to me that the science and mechanics of train control receive so little engineering consideration in the Railway Clubs of this country, for there is probably no part of the railroad equipment which can earn greater returns, investment considered, than the air brake, or which can cause greater loss if improperly installed, maintained, and operated. To the end then of a better understanding of why the changed conditions and rolling stock affect the efficiency of the air brake, I beg to call to your attention the following factors:

The Element of Time.

(a) Service Operations.

(b) Emergency Operations.

Flexibility—The Importance of

(a) Factors of.

(b) Time.

(c) Auxiliary Reservoir.

(d) Piston Travel.

(e) Braking Force.

Foundation Brake Gear.

(a) Single shoe gear.

(b) Double shoe gear.

Brake Shoes.

(a) Some of the characteristics of.

All of the above apply, to a more or less degree, to passenger and freight car brakes.

High Pressure Brakes for Passenger Cars.

(a) Velocity.

(b) Mass.

(c) Acceleration.

(d) Retardation (Rail) for often it is the rail that determines the minimum stop possible is, in fact, the starting point of the brake.

Empty and Load Brake for Freight Cars.

(a) Empty weight of car and its braking force. (Whenever the term braking power is used it should be understood as synonymous with braking force.)

(b) Loaded weight of car and its braking force.

(c) Level track—necessity for uniform braking force on.

(d) "Grades"—necessity for sufficient braking force.

Hand Brakes.

(a) Empty cars.

(b) Loaded cars.

(c) Effect of high capacity cars on the hand brakes.

Locomotive Brake Appliances.

(a) Compressor.

(b) Main, or Storage Reservoir.

(c) Governor.

(d) Engineer's valve used for manual operation of the brakes.

(e) Brake Apparatus.

Electrical Attachments for the Operation of Pneumatic Brakes.

(a) Energy.

(b) Acceleration.

(c) Retardation.

(d) Grade.

(e) Concussion.

So much for the brakes considered individually. Then they must be considered collectively, for you must appreciate that the operation, and perhaps all of the preceding considerations, may be greatly changed and, in fact, are changed by the combination in the many different ways and under the multitudinous conditions possible; therefore, we have to consider, in this engineering problem, the length of the train; the weight of the train; greater frequency of trains, and the effect of these things on the efficiency of the apparatus due to the larger volume of air to be handled and the time element necessarily involved; the shocks produced by the enormous energy necessarily inherent in long and heavy trains under movement; the air supply required, which, obviously, is greater with every vehicle added to a train; the larger apparatus required for the heavier cars; the effect of the lapse of time between the application of the brakes on the head end and the rear end of the train; the difference in time between the releasing of the brakes on the front and rear end of the train, and last, but not least, the possibility of the personal equation being equal to the many degrees of manipulation required and its ability to properly judge the right thing to do for each condition or occasion.

Then come the problems of installation, maintenance, and the information to be given the men of the different depart-

ments under which come the apparatus, and, of course, the instructions, general and particular, to all concerned.

CHANGED OPERATING CONDITIONS.

The fact that we have a transportation condition with us is a sufficient reason for a review of some of the problems contained therein. Transportation of either people or commodities, once commenced, has the faculty of naturally both increasing its need and its quantity, the effects being continuous and cumulative since it makes necessities of those things which without transportation would continue to be luxuries, even if they could be obtained at all.

Again, it enables remote quarters of the world to be reached and exploited, and in our own country, vast areas which without it would be worthless or rather undeveloped, have been made productive and contribute to the welfare and comfort of man. This tends to scatter the population and materially increase it in sections which otherwise would be sparsely inhabited, and this again in turn tends to make further need of improvements in transportation facilities. Thus we have rapidly grown from very few means or facilities for communication or transportation into our present highly developed, and still developing, magnitude of both railroads and the equipment necessary for their operation.

Among the problems which confront us are those of extension and betterment—extension into places which are as yet but inadequately served, and to others not yet developed because not yet penetrated by that most wonderful and useful servant of the people—the railroad—and the improvement of those facilities already existing in many localities at present; for, obviously, the sensible mode and method where facilities already exist is to increase their efficiency or capacity until waste becomes an unknown quantity before extension should be considered. In other words, the higher the efficiency, everything considered, the greater will be the returns in both service and profit from a given investment.

As an evidence of the wonderful development and changes which have taken place in the past thirty years, we will review a few of the things which graphically illustrate what has taken place, and I venture to say that it will startle some even of

those who have been constantly in touch with what has taken place.

As an introduction to this, we submit for your inspection the following tabulation:

RAILROAD DEVELOPMENT FROM 1889 TO 1910.

	1889	1910*	*Increase Per Cent*
Miles of Line	157,759	240,439	52.4
Miles of track . . .	200,950	351,276	75.0
Net Capital, etc.. . .	7,366,745,677	14,338,575,940	94.7
Pass. Carried	472,171,343	971,683,199	105.8
Tons Freight Carried	539,639,583	1,849,900,101	242.8
Loco. Number. . . .	29,036	58,947	103.0
Frt. Cars Number. .	854,031	2,153,121	150.1
Employees Number .	704,743	1,699,420	141.1
Emp. Compensation .	389,785,564	1,143,725,306	193.4

*Latest figures available (April, 1913).

Figures 1 and 2 supplement this tabulation.

PASSENGER CARS: 1905 1910

WEIGHTS INCREASED FROM 20,000 LBS. TO 138,000 LBS.— 150,000 LBS

FREIGHT CARS:

CAPACITY INCREASE IN LAST FIFTEEN YEARS FROM 40,000 LBS. TO 110,000 LBS.— 150,000 LBS.

LIGHT WEIGHT OF CAR INCREASED FROM .... 12,000 LBS. TO 48,000 LBS.— 50,000 LBS

PASSENGER TRAINS:

SCHEDULE SPEEDS FROM 30 M. P. H. TO 65 M. P. H.

ENERGY CONTAINED IN 5-CAR TRAIN.

OF LIGHT (30,000 LBS.) CARS AT 35 M. P. H. .... 6,200,000 FT. LBS.

OF HEAVY (127,000 LBS.) CARS AT 65 M. P. H. ...... 90,000,000 FT. LBS.

FREIGHT TRAINS:

TRAIN LENGTH FROM 15 TO 130 CARS.

TOTAL WEIGHT FROM .... 300 TO 4500 TONS.

ME 2012

Fig. 1.

LOCOMOTIVES:

WEIGHT ON DRIVERS HAS INCREASED, SINCE AIR BRAKE WAS INVENTED, FROM ...... 25,000 LBS. TO 270,000 LBS — 400,000 LBS. (1905 — 1910)

DRAW-BAR PULL OF LOCOMOTIVES HAS INCREASED, SINCE AIR BRAKE WAS INVENTED, FROM 10,000 LBS. TO OVER 60,000 LBS.— 100,000 LBS.

TOTAL WEIGHT OF LOCOMOTIVES AT PRESENT, UP TO .. 500,000 LBS.— 700,000 LBS

INCREASE IN WORKING PRESSURE SINCE AIR BRAKE WAS INVENTED, FROM 125 LBS. TO 225 LBS.

ME 2013

Fig 2.

The demonstration train (Fig. 3), which the Santa Fe Railroad Company hauled over its lines some months ago for educative purposes, also clearly illustrates this wonderful advancement.

SANTA FE DEMONSTRATION TRAIN - 1881 - 1911

RELATIVE WEIGHT

	OLD EQUIPMENT	NEW EQUIPMENT
Locomotive	133,000 pounds	850,000 pounds
Flat car	19,200 pounds	32,100 pounds
Coal car	22,000 pounds	36,500 pounds
Stock car	26,000 pounds	45,200 pounds
Box car	22,600 pounds	46,900 pounds
Way car	23,800 pounds	38,000 pounds
Smoker	49,400 pounds	119,100 pounds
Coach	50,300 pounds	123,100 pounds

RELATIVE CAPACITY

	OLD EQUIPMENT	NEW EQUIPMENT
Locomotve	14,000 pounds drawbar pull	110,000 pounds drawbar pull
Flat car	40,000 pounds	80,000 pounds
Coal car	50,000 pounds	80,000 pounds
Stock car	40,000 pounds	80 000 pounds
Box car	40,000 pounds	80,000 pounds
Smoker	28 passengers	86 passengers
Coach	48 passengers	75 passengers

RELATIVE COST

	OLD EQUIPMENT	NEW EQUIPMENT
Locomotive	$7,740 00	$43,880 00
Flat car	300 00	943 00
Coal car	338 00	1,036 00
Stock car	450 00	1,402 00
Box car	475.00	1,265 00
Way car	620.00	1,282 00
Smoker	3,000 00	12,124 00
Coach	3,605 00	12,820 00

ENGINE 3009

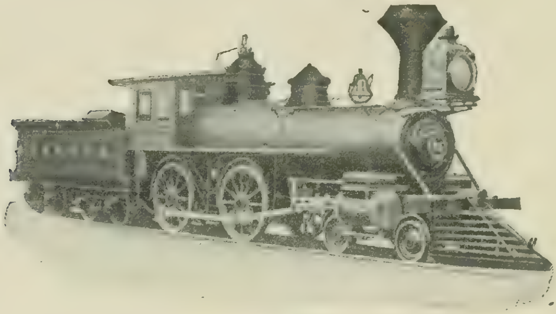
Santa Fe Type Mallet Compound
Largest Locomotive in the World
Built at Topeka Shops, 1911
Length 120 feet 7¾ inches
Cylinders 26 In x 38 In x 32 In stroke
Steam pressure 225 pounds
Capacity of tender 12 000 Gals Water
4,000 Gals Fuel Oil

OLDEST TRAIN CREW

E B Sill Conductor, 33 Years Service
Peter Tellin, Engineer, 39 Years Service.

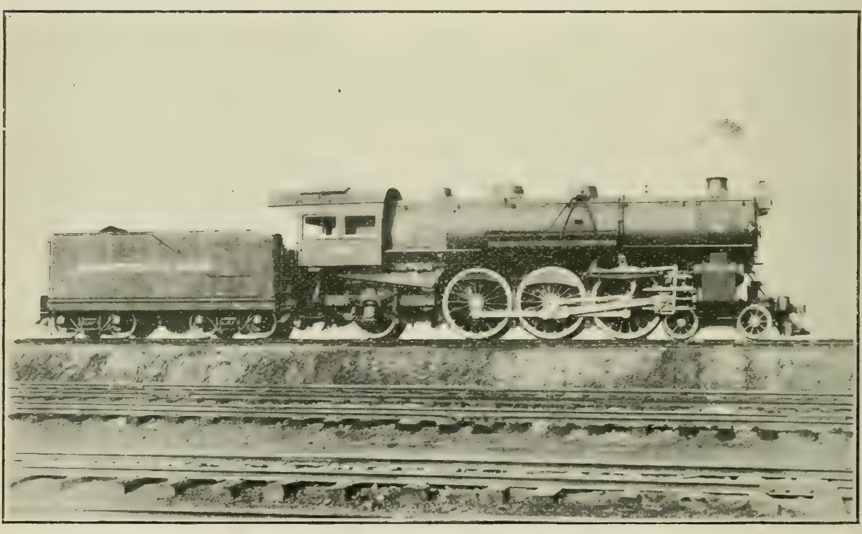
Fig. 3.

As a further illustration, Figures 4, 5, 6, 7, 8, 9, 10 and 11 show corresponding views of antiquated and modern equipment.



Antiquated Passenger Locomotive.

Fig. 4.



Modern Passenger Locomotive.

Fig. 5.

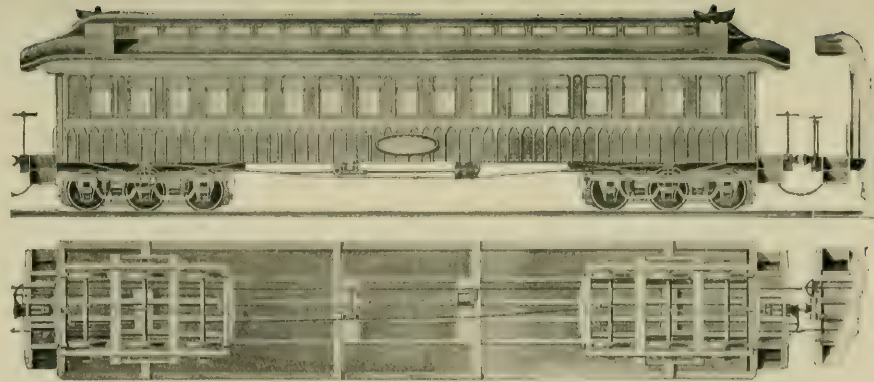


Fig. 6. Antiquated Passenger Car.

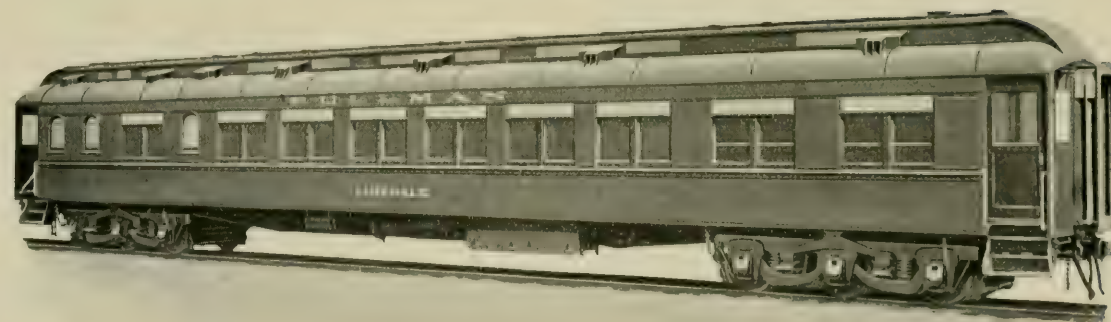


Fig. 7. Modern Passenger Car.

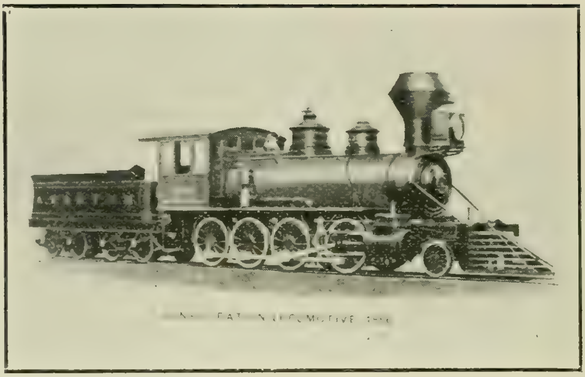


Fig. 8. Antiquated Freight Locomotive.

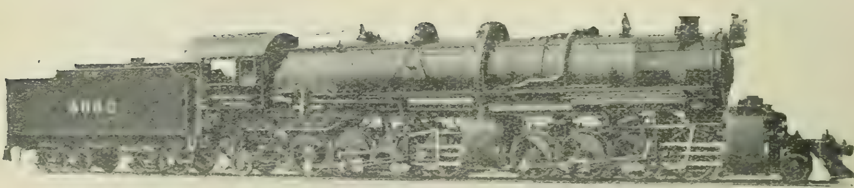


Fig. 9. Modern Freight Locomotive.

Fig. 10. Antiquated Freight Car.

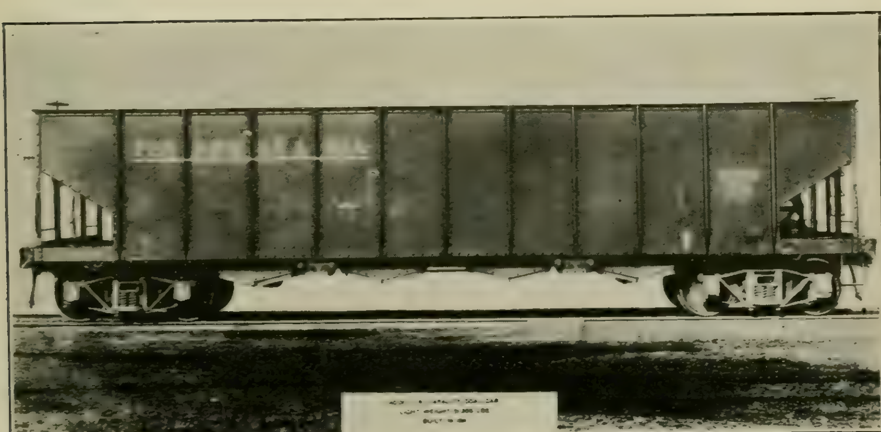


Fig. 11. Modern Freight Car.

Modern Passenger Train.
Fig. 12.

Figures 12 and 13 illustrate the modern passenger and freight trains respectively.

Modern Freight Train.
Fig. 13.

The diagrams on Figure 14 will serve for ready and graphic contrast and comparison of conditions 30 years ago and today.

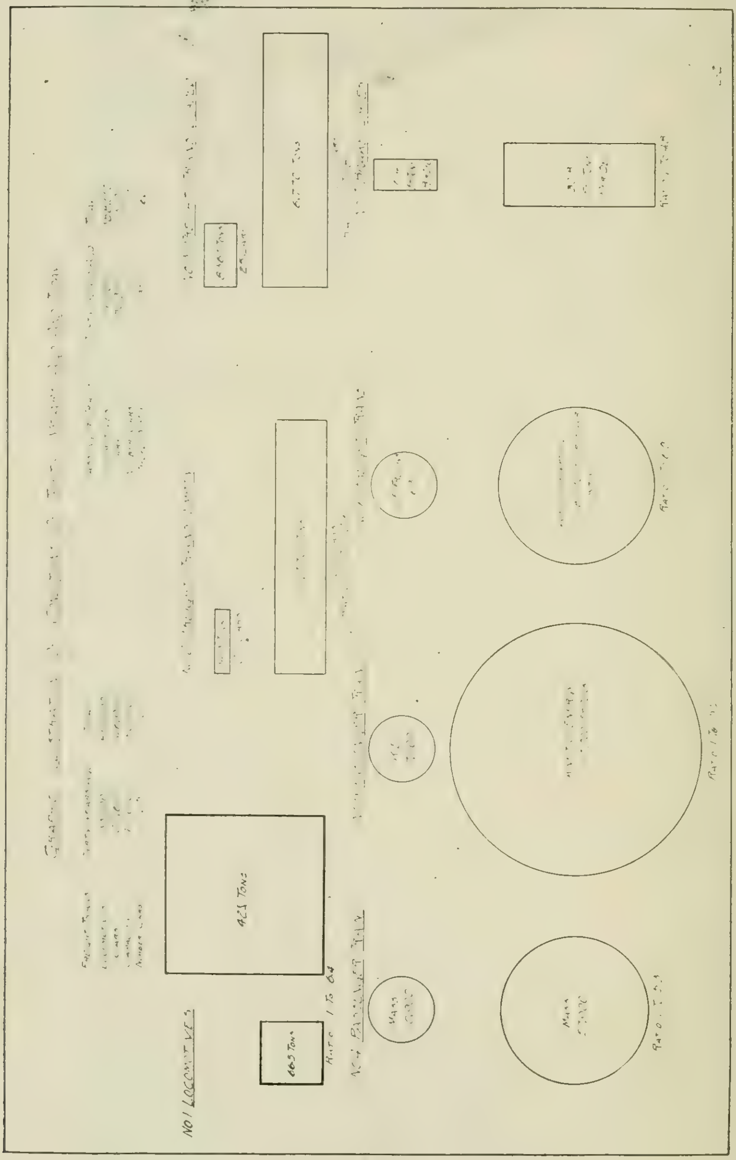


Fig. 14.

Figure 15 graphically illustrates the work which has to be done in stopping the passenger train mentioned thereon.

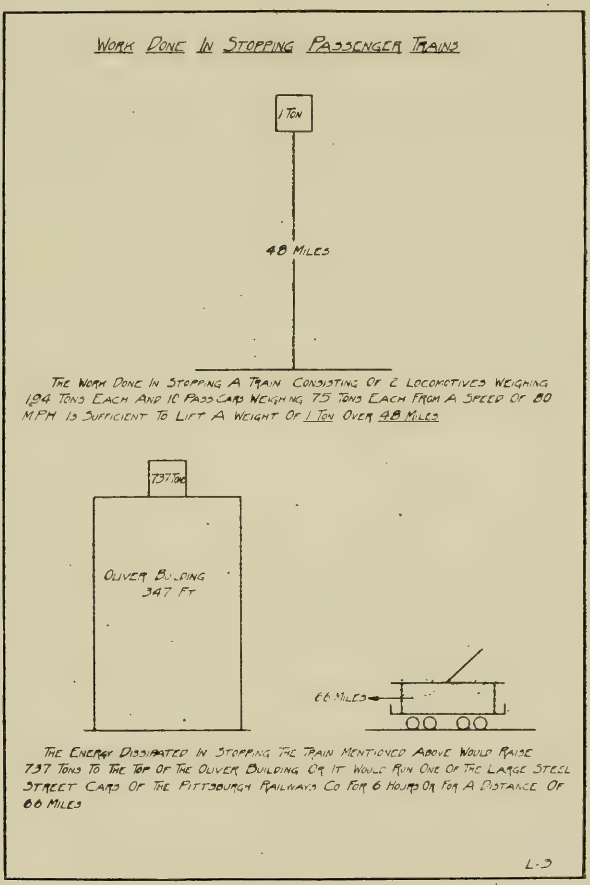


Fig. 15.

Figure 16 is for the same purpose, using, however, the energy developed by one of our modern 14″ guns as a basis for comparison.

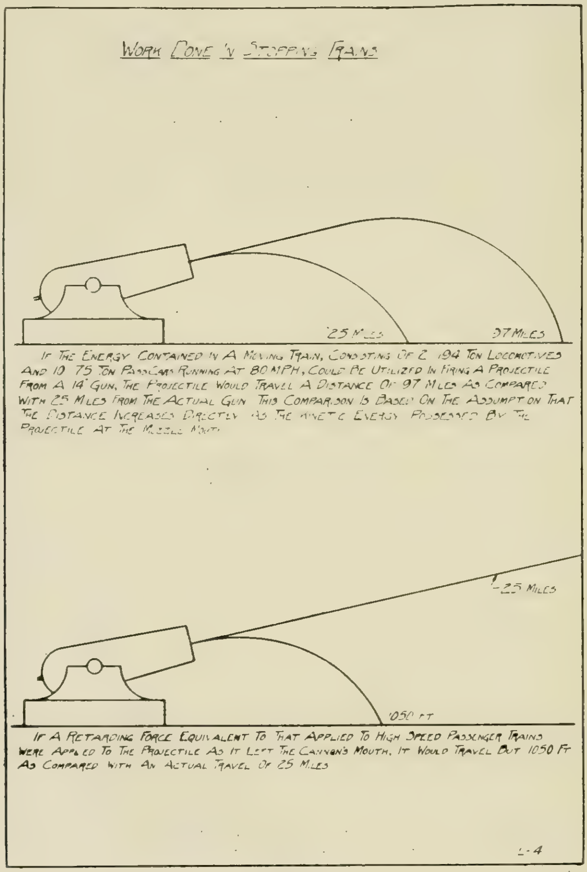


Fig. 16.

The foregoing illustrations clearly show the wonderfully changed conditions as far as magnitude is concerned, and as the controlling of such enormous masses when in motion is certainly as important as to give motion itself, it is obvious that the controlling mechanism is of vital importance, if not in the last analysis entirely the determining factor as to whether or not such development is permissible.

Here we have reached a place where opinions may differ according as they are swayed by knowledge, presumption or interest. For example, some will say we had controlling mechanism for the so-called antiquated vehicles or trains, and, therefore, it is self-evident that we still have at least the same controlling mechanism for the present trains, and, therefore, we see no great reason why controlling mechanism should enter into the present phase of the transportation development. There is a germ of sound reasoning in this, but, after all, sound reasoning hinges upon whether what was adequate for those conditions is adequate for the present conditions, and by the word "adequate" is meant the attainment of the same over-all efficiency and results as where then obtainable; if so, there can be no legitimate reason for considering the controlling means and mechanism except on the basis that the means and mechanism of former days were not all that was required to obtain the best "all-round" results. Any other basis of consideration must involve the one of being satisfied to let well enough alone, which often means calling "getting along" successful operation. As a matter of fact, however, the means and mechanism of thirty years ago did not give the best results even at that time, nor is that means and mechanism sufficient to operate the trains of to-day, or meet the conditions as well as it did the now almost forgotten conditions, for we now know the more modern mechanism if in use at that day would have given a far higher efficiency to the equipment and conditions of that day than did the apparatus of that time; while we also know that the very best means at present available will not give as efficient control of present-day conditions as was obtained with the old apparatus of the time.

PASSENGER SERVICE CONDITIONS.

Considering for the moment passenger equipment only, natural improvement, combined with the effort of railroad companies to attract business by superior equipment, and the demand of the traveling public for greater comfort when traveling, shorter schedules (higher speeds), and at the same time greater safety, has led to the development of heavier rolling stock. These cars and locomotives are of such weight that they cannot be as efficiently braked with the older type of air brake equipment as could the rolling stock of years gone by; and this

is true not only of the so-called service operations but is also true of emergency applications, since because of the very high speeds attained, longer trains, and the large cylinders necessarily employed, the time element, in the attainment of cylinder pressure, and the lowered brake shoe friction (by reason of the tremendous energy per brake shoe to be dissipated) means that the stopping distance, with the brake equipment remaining the same as with the rolling stock of previous years, is lengthened out several hundred feet. Obviously, therefore, if equal safety is to be maintained and the schedules operated profitably, at least as high (relatively) a rate of retardation must be provided as heretofore.

From these considerations it is, therefore, but fair to assume that the controlling mechanism should be increased in efficiency in at least the same proportion as the changed conditions have interfered with its former efficiency.

We submit an example that will show interestingly what the increase in the weight alone means to the operating department if it is to accomplish such a presumably desirable result. Under former conditions, the factor of safety in train handling was none too great, and it is, therefore, imperative that we should be able to control modern trains under present existing conditions, at least as safely and effectively as formerly.

To do this for twelve 150,000-pound passenger cars running at 60 M. P. H., it is necessary to provide means for controlling over 200,000,000 foot pounds of energy as compared with 6,000,000 foot pounds which was what the brakes of thirty years ago were called upon to control, with a train of five 30,000-pound cars running at 35 M. P. H. When the locomotive used with each train (one for the early and two for the modern conditions) is considered, the total energy in the modern train becomes 373,086,394 foot pounds, as compared with 9,800,000 foot pounds for the trains of thirty years ago.

It is not surprising, therefore, that the air brake art demands thoughtful consideration from trained and experienced minds if the railroad traffic of today is to be handled with a safety and efficiency equal to that of the days when the total energy to be reckoned with was one thirty-eighth as great.

If, therefore, the improvements for the heavier train and higher speeds of today permit of stopping in about the same

distance as could be done with the trains of thirty years ago, we should congratulate ourselves for having held our own.

Contrasting the modern Pullman car weighing 150,000 pounds and having six-wheel trucks, with the earlier passenger car having four-wheel trucks, and assuming that from a speed of 60 M. P. H., the stop should be made in 20 seconds, the work done would be 37.5 foot-tons per brake shoe per second, or over three times that of the earlier train, notwithstanding that there are twelve brake shoes to do the work instead of eight. The use of two brake shoes per wheel is rapidly becoming a necessity, not only on account of the great amount of work to be performed by each brake shoe, but also because the brake shoe pressure required by modern conditions, high speeds, and heavier cars, becomes so enormous that in emergency applications too great pressure is brought to bear on the pedestal and journals by the brake shoes acting on one side of the wheels.

The tremendous significance of this increase is but faintly appreciated by those who have not had occasion to investigate this aspect of the question. The cast-iron brake shoe is today practically as it was thirty years ago. This brake shoe must now do four times the amount of work by frictional resistance to the rotation of the wheel, as formerly. It may be suggested, "Why not quadruple the pressure per brake shoe?" But it also must be remembered that when the brake shoe pressure is multiplied by four, the actual retarding force is by no means quadrupled, for three vital adverse factors are being overlooked, viz., the effect of increased pressure, speed and time on the coefficient of friction (because of heat) between the wheel and the shoe. Also, that the brake shoe wear increases very rapidly with extremely high temperatures, and if for no other reason, it would warrant the expense of a two shoe per wheel installation for the saving in brake shoe wear and maintenance for the modern passenger train condition.

In general, therefore, it may be stated that the brake which would satisfactorily meet the requirements of past conditions falls short of the maximum efficiency which it should be possible to attain, in proportion to the increase of the requirements of present-day service over those of the past. The force of this is apparent when the same comparison is made between the locomotives and cars of the two periods. This review of the con-

ditions and what is involved, which is by no means exhaustive, will serve to give an idea of the magnitude of the problem. How the various stages of this problem have been solved, as they presented themselves, will be shown best by a consideration of the features and functions of the improved brake apparatus that was developed to meet the conditions just explained.

IMPROVED PASSENGER BRAKE EQUIPMENT.

While the fundamental service and emergency features of the quick action brake could not be departed from on account of the necessity for maintaining interchangeability of apparatus, and operative functions, it was clear that in designing a brake to meet these new conditions, not only must the fundamental features of the old brake be improved to their highest possible efficiency, but new features must be added, some of which were inherently impossible if the design were carried along the lines previously laid down.

While this is a point of departure, the development of the newer forms of locomotive, passenger and freight brakes was commenced and it may be fairly said with the incorporation of the new features, which will be explained in what follows, the air brake entered upon a new era of its history as distinct from that which preceded, covering the progress of the art from the development of the plain automatic brake to the high speed brake, as that era was distinct from those of the straight air brake and of the hand brake which marked the earlier history of the art.

Briefly stated, the recognition of the higher efficiency and added means required by the changed conditions referred to, led, in case of the passenger brake, to the incorporation of the following features in addition to those characteristic of the previous form of equipment.

1. Quick rise of brake cylinder pressure so that the braking force may reach its maximum in the shortest possible time and thus begin to be effective in reducing the speed when at its highest value—and when the increase in distance run before coming to a stop is greatest for every second's delay.

2. Uniform braking force on all cars, irrespective of size of equipment and variation in piston travel, thus contributing largely to the convenience and comfort of passengers, as well

as making the brake more reliable and therefore easier to manipulate.

3. Maintenance of both service and emergency brake cylinder pressures up to the capacity of the ample storage reservoirs of the cars. This is of the greatest advantage in overcoming the ever-present and often serious depletion of brake cylinder pressure by packing leather leakage.

4. Predetermined and fixed limiting of maximum service braking force, without a safety valve or other blow-off device. This maintains the proper margin between the force of service and emergency applications and tends to reduce wheel sliding without wasting air and with a minimum of apparatus, thus resulting in economy both of operation and maintenance.

5. Quick service feature to compensate for increased length of train and bring about more prompt, uniform and certain application of brakes.

6. Quick recharge of the auxiliary reservoirs to offset longer trains and larger cylinders and reservoirs and insure a prompt application of the brakes when desired and prevent the depletion of the auxiliary reservoir pressure.

7. Graduated release feature to add to the flexibility of the brake by making it possible to graduate the brakes off as well as on and so to handle the train more smoothly, with a greater saving of time, and a reduction in the amount of wheel sliding.

8. Much higher brake cylinder pressure obtained in emergency for the same brake pipe pressure carried, which pressure is maintained and retained during the complete stop, thus materially shortening the stops and adding greatly to the safety of the trains.

9. Automatic emergency application on depletion of brake pipe pressure. This is a safety and protective feature of great value, in that it insures sufficient braking force being automatically obtained to bring the train to a stop in case the system is depleted below a predetermined pressure either by careless manipulation or accidentally.

10. Full emergency braking force at any time, thus placing the maximum stopping power the brake has to offer at all times ready for use by the engineer whenever an emergency arises, irrespective of what may have preceded.

11. Separation of service and emergency features so that the necessary flexibility for service application can be obtained without impairing in the slightest the emergency features of the equipment and conversely, so that undesired quick action is practically impossible.

12. High maximum braking force secured with low total leverage, with correspondingly greater over-all efficiency of the brake.

So much for pneumatic improvements—all of which are now available and in use in some places.

Controlling means for passenger cars should, however, not be dismissed without a reference to operating the mechanism by electricity.

Actuating the brakes electrically results merely in the elimination of the time element of application, the retarding force coming solely from the pneumatic operation, consequently adding electric control without first developing the pneumatic features to a high degree is an expensive way of seeking improvement.

Not only this, but the heavier vehicles and lengthened trains have vastly increased the energy to be controlled and magnified the time element necessarily involved in so doing it. It is imperative that if the same relative freedom from surges, shocks and stresses is to be retained, the brake control must be much more flexible and responsive than has heretofore been the case.

With this end in view, great improvements have been made in the purely pneumatic brake, but full attainment is only possible when the pneumatic brake is operated electrically, as by this means the time element between the first and rear of the train is reduced, and the degree of retardation best suited to speed, can be measured to a degree, and it is obvious that with any class of rolling stock or make-up of train, that the elimination of the time element of brake operation will be both an improvement in this respect and also in the degree of perfection required in the human agents of its manipulation.

It is seldom that any one device or appliance offers the solution of so many problems, overcomes so many difficulties and at the same time utilizes such a vast energy that now is dangerous or goes to waste.

This system eliminates time as far as brake initiation and propagation is concerned.

It eliminates retardation shocks since it reduces brake operation as closely to the effects as though one vehicle only was being retarded.

It reduces the human equation to a very low factor, as it is so promptly responsive and flexible that correction of errors of judgment in manipulation can be made before inconvenience can occur.

It is free from many of the shortcomings of other brake equipments, special care being taken to insure its immunity from influences (which unavoidably exist) that cause brake operations contrary to what are contemplated or when not desired.

It increases the safety of train operation because full emergency braking force is available and obtainable always and is instantaneously effective.

For "service" (station stops, etc.) operation, it is especially valuable from a revenue standpoint, as it permits of stops being made in much less time with a reliability, smoothness and accuracy heretofore impossible.

It permits of accurate, instant and comprehensive communication between the engineer and train crew, or vice versa, thus contributing largely to co-operation and efficiency.

It combines in one brake or train control equipment the two elements (compressed air and electricity) that seem intended to complement each other for this purpose, and since the combination has proved in practice to be fully equal to its theory, it can hardly be called prophecy to say that its potentiality will be taken advantage of as it becomes known.

It is reliable, adaptable and complete and the writers have endeavored to so carefully and fully set forth the system as to permit those interested or concerned to verify all that is claimed for it. If this is accomplished, our purpose is served and much progress in this important and difficult field will have been made.

What this progress in passenger brake development represents in increased economy of train operation depends upon the view point, that is to say, if cost of change is to be the determining consideration then the improvement possesses no value to the one who so considers; if, however, he desires to secure the economy and increased efficiency arising from such development,

it can be obtained in various ways. As, for example, if the power consumed be kept the same with the shorter stop economy along the following lines is implied: (1) Higher average speeds, (2) shorter schedules, (3) for the same number of cars increased traffic capacity, (4) for fewer cars the same traffic capacity. If it is desired to secure economy by a reduction in power consumption, this can be accomplished, still retaining (1) the same average speeds and (2) the same schedules and capacity.

Assuming the stop to be reduced from 40 seconds to 20 seconds, it is obvious that it is possible to run with power on for 20 seconds where before the train was run with brakes on for this same 20 seconds. If the train does not accelerate while this power is on, a saving in running time between stops of 10 seconds is made. (If the train accelerates, a greater saving is made.) Assuming the trip to be two hours long when making 40-second stops and 100 stops to be made, reducing the time of stop to 20 seconds results in reducing the time of the trip to 1.44 hrs. That is, while the old train was making one trip, the new train would make 1.39 trips. Or if both trains consisted of 5 cars, in one day these 5 cars with the new train would have a value of 62 cars as compared with a value of 45 cars with the old train, and assuming 60 passengers per car the new train would be capable of carrying 3,720 people per day as compared with 2,700 people per day with the old train, or an increase of 38%. From this example it will be seen that under conditions of congested traffic, a brake of maximum efficient design will add as much to the carrying capacity of the road as would the purchase of numerous vehicles (2 for the example taken), which, however, it would not be possible to operate because the old brakes do not permit of the required headway, etc.

As to emergency applications, we assume the stop to be reduced one-half. It is obvious that the same margin of safety could be obtained with the headway cut in two making it possible to run twice as many trains as is possible with the longer stop and still retain the same safety factor.

As an evidence that the practical railroad man appreciates the increase in traffic capacity secured by the proper brake equipment, we quote from an interview with President T. P. Shonts, of the Interborough Rapid Transit Co., as given in the

New York Tribune of August 13th, 1911:

"Think, then, of what we have done for safety and for time saving by adopting, as we were the first to do, the Westinghouse Electro-Pneumatic Brake! It enables us to increase our train movement by letting one train follow another at shorter intervals than before, and it maintains a greater factor of safety."

From another view point, as we have seen, economy may be secured by reduced power consumption. The following calculations are submitted to indicate what this economy may be under conditions as assumed.

ARGUMENT.

In suburban passenger train service, train movement consists essentially of a period of acceleration and a period of deceleration, time between stops being the sum of these two. *If time between stops remain constant and the period of deceleration be shortened by the use of improved brake equipment, it is possible to introduce a period of coasting.* A period of coasting implies a lower maximum speed which permits of a shorter accelerating period or allows steam (current) to be cut off sooner. It is evident that a *reduced steam (current) consumption* gives a *reduced coal consumption.* The following calculations indicate what the reduction might be.

CONDITIONS.

Average distance between stops, 1.3 miles.
Average speed between stops, 24 M. P. H.
Average time stop with old equipment, 50 seconds.
Average time stop with improved equipment, 25 seconds.
Weight engine and tender, 136,000 lbs.
Number cars in train, 8.
Weight per car, 80,000 lbs.
Train resistance during acceleration, 10 lbs. per ton.
3.5 lbs. coal per I. H. P. hour.
Efficiency from cylinders to crank pins, 85%.
Number accelerating periods per run, 12.
Actual length run, 17 miles.
Total runs per day, 75.
Cost of coal, $2.50 per ton.
Trains operated 18 hours a day.

COAL USED WITH OLD EQUIPMENT.

1.3 miles÷24 M. P. H.=195 seconds between stops.

$195-50=145$ seconds time train accelerates.

$\frac{\text{Maximum Velocity}}{2} \times 145 + \frac{\text{Maximum Velocity}}{2} \times 50 = 1.3 \times 5280.$

Maximum Velocity=70.5 ft. per sec.=48.0 M. P. H.

Maximum Velocity is attained in 145 seconds.

Acceleration=$48.0 \div 145 = .33$ M. P. H. per sec.

Weight train=$136000+(8 \times 80000)=776{,}000$ lbs.

Accelerating force=$\frac{776000}{32.2} \times \frac{.33 \times 5280}{3600} = 11{,}700$ lbs.

Force necessary to overcome train resistance, accelerate moving parts, etc.=

$\frac{766000 \times 10}{2000} = 3{,}830$ lbs.

Total force to move train at rate indicated=$11{,}700+3{,}830=15{,}530$ lbs.

H. P. at average speed of 24 M. P. H.=$\frac{15530 \times 24 \times 1.47}{550}=1000$ H. P.

I. H. P. at 85% efficiency=$1000 \div .85 = 1180$ I. H. P.

Coal consumption=$1180 \times 3.5 = 4120$ lbs. per I. H. P. hr.

Coal consumption per acceleration=$\frac{4120 \times 145}{3600} = 166$ lbs.

Coal consumption per run=$166 \times 12 = 1999$ lbs.

Coal consumption per year=$1999 \times 75 \times 313 \div 2000 = 23{,}400$ tons.

COAL USED WITH IMPROVED EQUIPMENT.

195 seconds between stops as with old equipment.

195-25=170 seconds time of combined acceleration and coasting.

Maximum velocity=M. P. H. per sec. times time of acceleration.

Assume M. P. H. per sec. same as with old equipment=.33 M. P. H. per sec.

$\frac{\text{Max. Velocity} \times \text{time of acceleration}}{2}$ + av. velocity coasting × time of coasting + av. velocity deceleration. × time of deceleration=1.3×5280.

From above, time of acceleration=126 seconds.

Coal consumption per acceleration=$\frac{4120 \times 126}{3600} = 144$ lbs.

Coal consumption per run=$144 \times 12 = 1730$ lbs.

Coal consumption per year=$1730 \times 75 \times 313 \div 2000 = 20{,}300$ tons.

SAVING IN COAL.

Tons per year old equipment	23,400
Tons per year improved equipment	20,300
Saving	3,100 tons

3,100 tons at \$2.50 per ton=\$7,750.

RETURN REALIZED ON INVESTMENT.

18 hours÷75 trains=.24 hours between trains average.

17 miles÷24 M. P. H.=.708 hrs. per trip one way.

$.708 \times 2 \div .24 = 5.9 = 6$ trains.

Allow two trains for uneven spacing.

Total trains=8.

Cars per train=8.

Total cars required for service=64.

Assume old equipment to be returned and improved equipment to be put on at \$200.00 per car.

Cost improved equipment=64×200=\$12,800.

Return on investment=$7750 \div 12{,}800 = 60.5\%$ per year.

While these calculations assume certain conditions of operation, it must not be thought they are in any manner exceptional, for there is no operation but what can be improved in earning capacity to a greater or less degree by taking advantage of modern brake apparatus.

So much for passenger brake improvements.

FREIGHT SERVICE CONDITIONS AND EQUIPMENT

Air brake equipment for freight cars has developed through several distinct stages: First, straight air, then plain automatic, then quick action automatic, and now the present quick service, uniform release, uniform re-charge automatic; each serving in turn to meet the special conditions pertaining during the different periods.

The most important factor making it necessary to change the type of Freight Car Equipment has been the increasing length of trains, as instanced by the change from short trains on which straight air was used, to the 25 and 30-car trains equipped with plain automatic; from the 30 to 50-car trains for which the quick action automatic was designed, to the 50 to 100-

car trains of today, which have made the quick service uniform release, uniform re-charge equipment a necessity.

The distinctive features which are peculiar to each type of freight air brake equipment mentioned above have mainly to do with *the functions which assist in approaching uniform and instantaneous application and release of brakes.*

Automatic air brake equipments are operated by differentials of pressure originating, as far as the manual operation is concerned, at the head of the train by the brake valve on the locomotive.

As trains increased in length, the brake valve was developed to meet the changing conditions, but it became evident

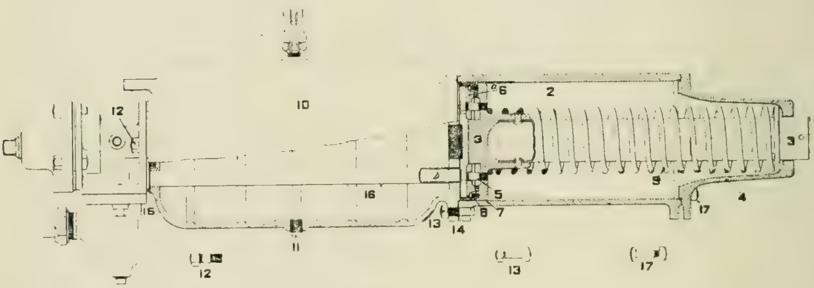


Fig. 17.

that, as the length of the brake pipe increased, the distance the air must travel to reach the exhaust at the brake valve, the friction in the pipe, and the volume to be handled, caused the pressure to reduce so slowly that many brakes would not apply, and increased the time of securing the differential to such an extent that when the entire differential was created at the brake valve the application of brakes would be completed at the head end of train so long in advance of any check to the rear end, that the slack ran in, causing destructive shocks during heavy applications.

It became necessary, therefore, after the use of the brake valve to create the differentials as far as could be permitted, to have the *triple valves* assist in making the brake application *by creating differentials of pressure locally on each vehicle* to assist in running the serial applications of the brakes through the train fast enough to avoid shocks. This was the feature employed as being an absolute necessity, i. e., local brake pipe reductions, when the "Quick Action Triple Valve" was devel-

oped, which cut down the time of serial application of brakes in *emergency only* by making such brake pipe reduction on each vehicle.

The present operating conditions with trains of still greater length up to 100 cars and regularly 60 to 75 cars, necessitate a decrease in time of serial application of brakes through the train in the *service requirements,* i. e., ordinary uses of the brakes other than in emergency, similar to what was brought about by the quick action features of the type "H" quick action triple valves, which, as explained, was confined entirely to *emergency* applications.

With the present 50 and 100-car freight trains excessive shocks to the equipment and shifting of lading are likely to occur during the release of brakes with standard equipment, owing to the earlier release of triples on vehicles at head end, to such an extent that it has been necessary to require engineers to complete the stop after making a brake application, rather than to attempt a release of brakes at slow speeds. This has created a demand for a *uniform release* feature to compensate for this difference in time of release, so that a release of brakes may be made at any time desired.

The present long trains also bring a demand for more *uniform application* of brakes as to pressures, making it necessary to have *uniform re-charge* of auxiliary reservoirs.

The longer trains, with additional brake pipe volume, pipe friction and leakage at hose connections, make it all the more difficult to get rise of pressure in brake pipe at the rear end of train with sufficient promptness to insure release of all brakes, especially back of the middle of train, resulting in frequent starting from a stop, with standard equipment, with an occasional brake or brakes not released, causing shocks and sliding of wheels.

It has been determined, by careful investigation, that fully 90 per cent of all slid-flat wheels in freight trains occur from non-release of brakes after a stop, rather than the supposed sliding during progress of stop.

When conditions as above enumerated became sufficiently general a demand was created for development in the air brake art to meet the new requirements, which were beyond the limitations of equipment already in use, hence it was natural that the quick

action triple valves should have refinements added to meet the new conditions.

It was necessary, however, to confine any and all improvements in equipment to those which could be used to advantage in trains with equipment now on cars without change in hose connection or additions thereto. It was also necessary, if possible, to confine the improvements to features which could be added, if desired, to the standard quick action triple valves already in use, and also to improve the operation of old equipment if mixed in trains with the improved type.

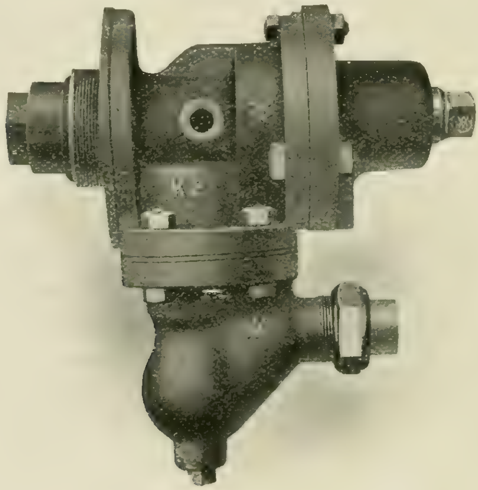


Fig. 18.

This resulted in the development of the type "K" *triple valve* (Fig. 18), performing all functions of the type "H," with the addition of the

QUICK SERVICE FEATURE,

UNIFORM RELEASE FEATURE,

UNIFORM RE-CHARGE FEATURE,

all of which features can be added to the Westinghouse standard type "H" quick action triple valves.

The novel features of the "K" triple valves are as follows:

The Quick Service Feature (as shown in Fig. 19), which hastens the time of serial action of brakes through long trains in service applications in a similar way to the hastening of the

time of serial action in emergency, the emergency being the same as before; the service time, however, being practically cut in two, for a train of 75 cars or more.

This result is brought about by each "K" triple valve *making a local reduction of brake pipe pressure* on each vehicle by taking a quantity of air out of the brake pipe and admitting the same to brake cylinder, the local reduction thus made setting the triple valve in action on next adjoining vehicle; such action, by the way, resulting whether the next triple be "K," "H" or any other type. The brake pipe air expanded into the brake cylinder assists the auxiliary reservoir air to quickly move the brake piston beyond the leakage groove, and also to force the packing leather out against the walls of the cylinder.

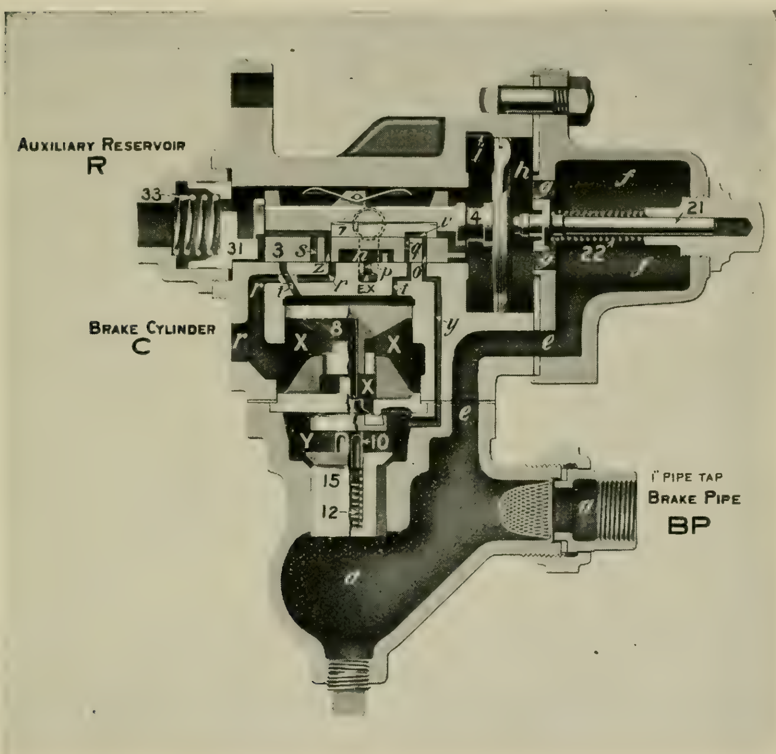


Fig. 19.

This local reduction on each vehicle results in complete serial action of brakes through trains of any length with only

very light reductions on head end, securing the *effective* use of brakes *uniformly* on all vehicles in trains of any length, whereas, with triple valves other than "K," the serial action in service application often ceases entirely before reaching the middle of the train, or skips miscellaneously through long trains, resulting in only one-third to one-half of brakes being applied, except in emergency.

The Uniform Release Feature (as shown in Fig. 20) was

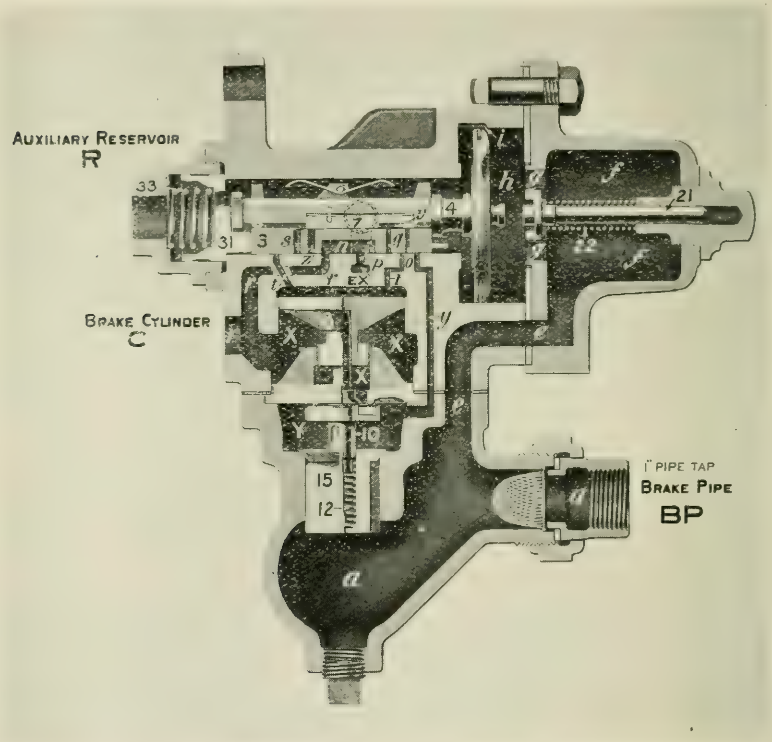


Fig. 20.

added to retard the escape of pressure from the brake cylinder on vehicles on head end of train until the pressure in brake pipe could be raised sufficiently on rear end to start release of rear brakes, then, all brakes continuing to release together, zero being reached at about the same time on all vehicles, shocks and break-in-twos are avoided, making it possible to permit the engineers to release the brakes on trains equipped with "K" triple

valves at any time desired, without the necessity of completing a stop, this uniform release feature adding to the cars the well-known assistance derived from the use of independent brakes on the locomotive.

The *uniform re-charge feature* was added to the "K" triple to retard the re-charge of auxiliary reservoirs on vehicles at head end sufficiently to compensate for the difference in time required to raise pressure in brake pipe at rear end of long train, the auxiliaries on rear end being the particular governing factor, especially in grade work, to secure uniform work done by brakes on all vehicles.

This uniform re-charge is brought about by slightly restricting the ports to the auxiliaries on head end, but it will be appreciated that, as the pressure is higher in the brake pipe on such head vehicles, the rate of re-charge through the smaller port thus secured will be practically the same as with the less differential working against the unrestricted ports opened to the auxiliary reservoirs on vehicles in rear end of train, so that pressure in all auxiliary reservoirs will reach maximum at about the same time.

The uniform re-charge feature, by having the smaller openings deducting pressure from brake pipe on head end, makes it easier to secure prompt rise of pressure in brake pipe on rear end of train, thus practically insuring the movement of all triple valves in train to release position, avoiding stuck brakes and slid-flat wheels caused by non-release of brakes. This feature also prevents over-charge of auxiliary reservoirs on head end of train during release and re-charging, thus avoiding undesired re-application of brakes.

It has been determined also that a large number of break-in-twos occur from attempts to start long freight trains with brakes applied at rear end. The *uniform re-charge* feature of "K" triple valve, insuring the release of all brakes in the train, guards against brakes remaining applied at rear end and causing break-in-twos, and also the *uniform release* feature, retarding the escape of brake cylinder pressure on head end until rear brakes have started to release, *makes it difficult for engineers to move trains until all wheels can revolve.*

ADVANTAGES OF IMPROVED FREIGHT BRAKE EQUIPMENT.

The advantages of the improvements and refinements of the

"K" triple valve are as follows:

1. That with all brakes applied with light reductions, trains can be controlled with the "K" triple valves with less shock to equipment and damage to lading en route.

2. That the control of trains with light reductions secures greater reserve in air brake equipment with "K" triple valves, as several light reductions can be made from the same stored volume as would be required for one heavy application to secure similar control with standard triple valves. This means much in the handling of increased tonnage on grades.

3. The quick service feature of "K" triple valves favorably affecting other triples, whatever their type, on adjacent vehicles, makes it possible to secure improved results with only a partial equipment of "K" triple valves, securing the improved results in proportion to the number of "K" triple valves in the train, plus the advantages secured from the favorable effect upon other adjacent triple valves.

4. The uniform release feature of the "K" triple valve, making it possible to secure uniform and prompt release of all brakes in the train and reducing shocks to equipment and damage to lading, is of great importance, even though engineers were not permitted to release brakes at any and all times, as whenever a release is made with the "K" triple valves, there is much less shock to the equipment and lading.

5. By the use of the "K" triple valves the same air supply capacity on the locomotive will serve for longer trains than with standard equipment.

6. The combined benefits of the "ET" locomotive equipment and "K" triple valves in securing prompt release of all brakes in the train is of great importance as bearing upon the reduction of the number of break-in-twos and slid-flat wheels.

It will be noted that what has been said in regard to freight train control has dealt chiefly with compensating factors for the evils brought into existence by longer trains, these evils being chiefly those arising from the very great increased quantity of air required and its distance from the source of manipulation. This made the brake very erratic and unreliable in its action, besides interfering seriously with the very essential factor of uniformity of action, which, when existing to the maximum degree in a brake, means a perfect medium for train control. There is another condition, however, that is quite as serious,

perhaps more so, than the foregoing, namely, that of the very great difference of retarding force developed on the car empty and the car loaded; therefore, we may profitably spend a short time in considering the longer, heavier freight trains.

THE CONTROL OF LONG, HEAVY FREIGHT TRAINS IN LEVEL ROAD AND IN GRADE SERVICE.

During the past two or three years the use of heavy freight cars, of increased capacity, has been steadily growing, and the problem of properly controlling long and heavy trains, especially on grades, has become correspondingly more pressing. If it be taken for granted that the controlling of trains of ten or twenty years ago left nothing to be desired, it follows that *similar traffic* of today is as well taken care of as it was then.

However, not only have the traffic demands become many time more severe, in the directions of heavier tonnage, longer and more numerous trains and higher speeds, but the results of these new conditions have demonstrated more clearly than ever before the advantages which would have resulted from a better control of the trains a few years ago, under the conditions then existing and the necessity of an improved control of the trains of the present time, if the present possibilities of the railroad and its equipment are to be fully realized.

It is a fact that on the heavier cars of today the braking force available with the ordinary equipment is all that could be desired for the control of such cars when *empty*. It is also true that the ratio of the capacity to the light weight of such cars is not greatly in excess of that of the lower capacity cars. The *loaded* car is therefore proportionately as well braked now as heretofore. From this it might appear that there is no more need now than there ever was for an available braking force more nearly proportionate to the weight of the loaded car than is furnished by the ordinary brake equipment (which is necessarily proportioned to the weight of the car when empty). Even aside from the question of controlling trains by hand brakes this requires analysis, however, because, in the first place, the brake installation on a car is not necessarily what it should be, merely because it was the best in existence at the time it was applied. In the second place, the use of cars of such considerable weights and capacities as are now more or less common, does introduce new possibilities which cannot be considered as matters of pro-

portionate effects alone. The damage to lading and equipment depends upon the absolute magnitude of the forces developed during braking; the shocks due to slack running in or out violently; and the additional work imposed on the good brakes in a train by such partial or complete failure of the brake apparatus on individual cars as will always result in service due to inability to maintain 100% efficiency in installation, inspection and maintenance.

It is for reasons of this sort that the heavier passenger cars and *empty* freight cars are provided with a maximum available braking force corresponding to their weight, and it is, without doubt, a fact that the same would have been done long ago for loaded cars had there been any satisfactory means whereby this very natural and desirable end could have been accomplished.

What the above facts signify can best be appreciated by considering a concrete case. In so doing the main considerations are:

(1) *Adequate Control of Trains* on level track with particular reference to *uniformity* of braking forces on loaded and empty cars, in the same train.

(2) *Adequate Stopping Power*, with particular reference to the *retarding force* available on *grades*.

(3) The relation of the *hand brake* to the two factors just mentioned.

Adequate Control of Trains on Level Track.

The controlling of freight trains on level tracks involves

(a) Uniformity of brake action on different vehicles in the train.

(b) Stopping power in cases of emergency.

(a) *Uniformity of brake action* is by far the most important in level road work, because the effects of a non-uniform action of the brakes in the train is felt in every stop of every train, while cases of emergency are relatively rare and many times unavoidable at the very best.

Figure 21 compares the resulting braking force, for three 70-ton coal cars, light weight 54000 lbs. with 10% overload capacity and under varying conditions.

The effect of a braking force on the loaded car only about one-fourth that on the empty car is to set up strains between

couplings, which, though not excessive when considered as static pulls, may be extremely severe, when suddenly applied by a quick reversal of stress due to a sudden running in or out of the slack.

TABLE 1.

CONDITION OF CAR.	EMPTY	FULLY LOADED	FULLY LOADED
WEIGHT OF CAR IN POUNDS	54000	208,000	208,000
BRAKE EQUIPMENT	STANDARD OR EMPTY & LOAD	STANDARD	EMPTY & LOAD
NOMINAL BRAKING FORCE. (FULL SERVICE BRAKE PIPE REDUCTION)	60%	15.6 %	40 %
NOMINAL BRAKING FORCE (10 LBS. BRAKE PIPE REDUCTION.)	20.4%	5.3 %	13.6%

Fig. 21.

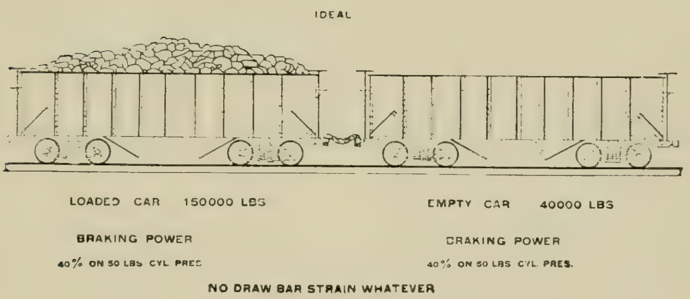


Fig. 22.

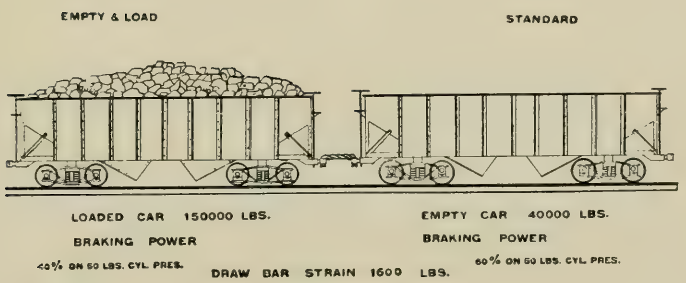


Fig. 23.

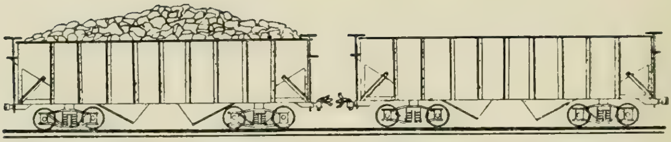


Fig. 24.

The illustrations on Figs. 22, 23 and 24 show comparatively what strains are set up between cars coupled together, with brakes applied.

Fig. 22 shows the ideal condition, that is, braking forces proportional to load on wheels in every instance. This results in uniform retardation on all cars, whether loaded or empty, which would permit of a much improved control of the trains with entire freedom from shocks. This would be secured, moreover, with a lower braking force on the empty cars than must be used with the present standard brake equipment because of the higher braked empty cars at the present time having to stop the much lower braked loaded cars.

To attain the ideal condition shown in Fig. 22 would be impracticable and unnecessary. Figure 23 illustrates a practicable approach to the ideal condition and with provision for a closer approach in future as conditions permit. The most prolific source of rough handling and damage to equipment and lading is eliminated by leaving the braking force on the empty car where it is at present aud increasing that on the loaded car by the operation of the empty and load brake equipment, substantially in proportion to the ordinary load carried. From Fig. 23, the braking forces of the two cars compare as 60 to 40, so that if operated singly their rates of retardation or deceleration during a brake application would be in the same proportion, assuming a constant coefficient of friction.

Since, however, the two cars are not operated singly, their deceleration must be the same, which necessitates an equalization of deceleration through the intervention of a draw-bar strain. In other words, the car with the less braking force must drag

the car with the greater braking force. As the total retarding force acting on the two cars can be calculated from the known weight and braking forces and assumed rigging efficiencies and co-efficients of friction, the average deceleration can be found from the fundamental law that the retarding force divided by the mass equals the deceleration. For conditions, as given in Figure 23, the deceleration has a value of 1.815 ft. per sec. per sec. The deceleration of the empty car alone would be 2.40 ft. per sec. per sec. Hence the loaded car has changed the deceleration of the empty car from 2.46 to 1.815, or it has given the empty car an acceleration of 2.46—1.815=.645 ft. per sec. per sec. Since force equals mass times acceleration, the force acting through the draw-bar must have been 800 lbs. This is the average draw-bar strain acting throughout the stop. The maximum value would be at least twice the average value or 1600 lbs.

These draw-bar strains are more severe when the present standard equipment is used as illustrated by Fig. 24. The total effectiveness of the brake is reduced practically in proportion to the load carried and the chances for severe strains to accumulate at some critical point in the train and so cause a brake-in-two are greatly increased. Fig. 24 shows that the empty car developed a braking force of 60%, while the loaded car developed a braking force of only 16%. Since these cars will attempt to stop in different times, a draw-bar strain will again arise. By calculations similar to the above, the average value of this strain is found to be 1767 lbs. and the maximum 3534. This strain is more than twice that existing with the empty and load brake equipment.

For ready reference, these calculations in detail with the necessary formulæ are embodied in this paper as Figs. 25 and 26. A study of these figures should make clear the method of attacking such problems and should enable anyone to calculate the strain for any particular set of conditions.

These strains are the strains existing in draw-bars because of different braking forces which cause cars with high braking forces to endeavor to stop in less time than cars with lower braking forces. What really damages draw-bars and cars, however, is not these strains which even in long trains are not excessive, but the enormous strains resulting from the sudden taking up of slack.

Formulae To Determine Approximately Draw Bar Strain Bewteen Two Cars Braked With Unequal Braking Forces

$F = WPef$ (1) $M = \frac{W}{g}$ (2) $p = \frac{F}{M}$ (3)

F = Retarding Force, Lbs
W = Weight, Lbs
P = Braking Force, Per Cent
e = Brake Rigging Efficiency, Average Value = .85
f = Coefficient Friction, Average Value = .15
M = Mass
g = Acceleration Of Gravity = 32.2 Ft Per Sec. Per Sec.
p = Deceleration, Ft Per Sec Per Sec.

L-17

Fig. 25.

Examples Of Draw Bar Strain

Find The Average Draw Bar Strain Bewteen Two Cars, One Of Which Weighs 40,000 Lbs. And Is Being Braked With 60% Braking Force And The Other Weighs 150,000 Lbs. And Is Being Braked With 40% Braking Force. Compare This Strain With That Existing Bewteen The Same Cars When The Braking Forces Are 60% And 16% Respectively.

For The First Case, Substitute In Formula (1) $F = WPef$ — $W = 40{,}000$, $P = .60$, $e = .85$, $f = .15$ And $W' = 150{,}000$, $P' = .40$, $e = .85$, $f = .15$
Or $F = 40{,}000 \times .60 \times .85 \times .15 = 3060$ Lbs. $F' = 150{,}000 \times .40 \times .85 \times .15 = 7650$ Lbs.
That Is, The External Forces Acting On The Two Cars Considered As A Free Body Are Two Retarding Forces In The Same Direction, One Of 3060 Lbs. And The Other Of 7650 Lbs These May Be Considered As One Retarding Force Of $3060 + 7650 = 10{,}710$ Lbs. Acting On The Free Body (That Is, The Two Cars).
Substituting In Formula (2) $M = \frac{W}{g}$ $M = (40{,}000 + 150{,}000) \div 32.2 = 5900$
Also Substituting In Formula (3) $p = \frac{F}{M}$ $p = 10{,}710 \div 5900 = 1.815$ Ft. Per Sec. Per Sec.
That Is, The Average Deceleration Of The Two Cars Is 1.815 Ft Per Sec Per Sec

Considering The Empty Car Alone, Its Deceleration Would Be $p = 3060 \div 1240$ ($F = 3060$, $M = 1240 = 40{,}000 \div 32.2$) $= 2.46$ Ft Per Sec Per Sec But The Deceleration Of The Empty Car Is Actually 1.815 Ft. Per Sec. Per Sec Consequently The Draw Bar Pull Must Change The Deceleration Of The Empty Car From 2.46 To 1.815 Or The Pull Is Producing An Acceleration Of $2.46 - 1.815 = .645$ Ft. Per Sec. Per Sec.

From (3) $p = \frac{F}{M}$ $F = pM = .645 \times 1240 = 800$ Lbs. = Average Draw Bar Strain

For Second Case By Similiar Method Draw Bar Strain Is Found To Be 1767 Lbs

Assuming That The Maximum Strain Is Twice The Average Strain, Which Is Not An Unreasonable Assumption. The Maximum Strains In The Two Cases Are 1600 Lbs. And 3534 Lbs.

L-18

Fig. 26.

The value of such strains varies greatly depending upon local conditions in the train. It may be stated generally, however, that these strains will be greater, the greater the difference in braking forces on the several cars. This comes about because during a brake application before the slack is taken up, the cars can act independently, so that their velocity will be determined by their braking force, assuming the same initial velocity. But after the slack is taken up, all have the same velocity. This equalization of velocity takes place in a very short interval of time and is manifested by a jerk in the train. It is evident that the greater the difference in velocity before the jerk or shock, the greater the strain will be and also that this strain will be greater the shorter the time in which the equalization takes place.

To illustrate what the numerical values of this strain may be, take conditions as in Fig. 23. Assume that just before the slack is all out, the cars have a difference of velocity of 1 M. P. H., which has come about because of the different rates of retardation of the two cars. It is impossible to calculate precisely this difference as it depends upon the time necessary to take up the slack, the difference in time of application of the brakes and upon other factors which make an extended mathematical investigation impracticable. Let us assume further, therefore, that the loaded car has a velocity of 20 M. P. H. and the empty car 19 M. P. H. After the shock resulting in equalization of velocity, the two cars will have a common velocity whose value will be some intermediate value between 19 and 20. To determine this velocity, it is necessary to make use of the fundamental law that momentum cannot be destroyed; that is, that the momentum before the shock equals the momentum after the shock. From this law, we find the velocity after the shock to be 19.8 M. P. H. A second fundamental law is that change in momentum equals the force producing such change multiplied by the time during which it acts. The empty car has changed its velocity from 19 M. P. H. to 19.8 M. P. H., which equals a change of momentum of 1439. If the equalization of velocity takes place in .1 of a sec., the necessary force acting through the draw-bar to change the velocity of the empty car from 19 M. P. H. to 19.8 M. P. H. will be 14,390 lbs.

This strain will be very much greater for standard equip-

ment as shown in Fig. 24 on account of the greater difference in braking forces. Since we assumed that a difference of braking force of 20% caused a difference of velocity of 1 M. P. H., we must conclude that a difference of braking force of 44%—which is the case with the standard equipment—would cause a difference of velocity of 2.2 M. P. H. Considering again that the loaded car has a velocity of 20 M. P. H., the empty car must have a velocity of 17.8 M. P. H. The equalization of such velocities in .1 of a second with car weights as given in Fig. 24, would require a draw-bar strain of 31,657 lbs.

Figures 27 and 28 furnish not only detail calculations for the conditions here assumed, but also a general plan of procedure which may be applied to any set of conditions.

It should be noted that not only is the strain with standard equipment 120% greater than with empty and load equipment, but that the strain with standard equipment has an absolute value sufficient to damage equipment and lading if conditions are favorable. These strains are calculated for but two cars and will be greatly increased when trains are considered.

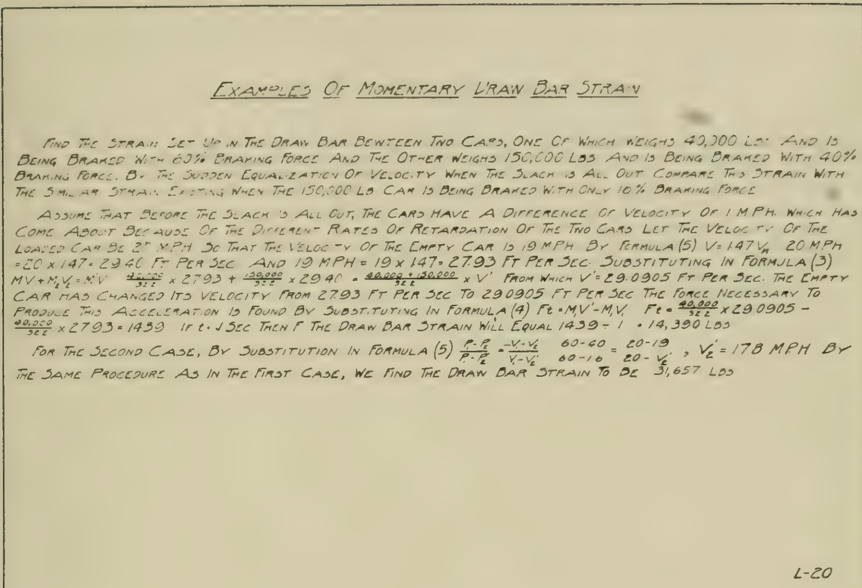
FORMULAE TO DETERMINE APPROXIMATELY DRAW BAR STRAIN, CAUSED BY SUDDEN TAKING UP OF SLACK, BEWTEEN TWO CARS BRAKED WITH UNEQUAL BRAKING FORCE.

MV = Momentum	(1)	$Ft = M_1V' - M_1V_1$	(4)
$M = \frac{W}{g}$	(2)	$\frac{P_1 - P_2}{P_1 - P_2'} = \frac{V_1 - V_2}{V_1 - V_2'}$	(5)
$M_1V_1 + M_2V_2 = M'V'$	(3)	$V = 147\ V_M$	(6)

M = Mass
V = Velocity, Ft Per Sec
W = Weight, Lbs.
g = Acceleration of Gravity = 32.2 Ft Per Sec Per Sec
M_1 = Mass Car (1)
V_1 = Velocity Car (1) Ft Per Sec Before Shock
M_2 = Mass Car (2)
V_2 = Velocity Car (2) Ft. Per Sec Before Shock
M' = Mass Two Cars = $M_1 + M_2$
V' = Common Velocity After Shock, Ft Per Sec
F = Draw Bar Strain, Lbs
t = Time Secs During Which Draw Bar Strain F Acts
P_1 = Braking Force Per Cent Car (1)
P_2 = Braking Force Per Cent Car (2)
P_2' = Second Value Braking Force Car (2) Per Cent
V_2' = Velocity Car (2) Corresponding To Braking Force P_2'
V_M = Velocity, Miles Per Hour

L-19

Fig. 27.



EXAMPLES OF MOMENTARY DRAW BAR STRAIN

FIND THE STRAIN SET UP IN THE DRAW BAR BEWTEEN TWO CARS, ONE OF WHICH WEIGHS 40,000 LBS AND IS BEING BRAKED WITH 60% BRAKING FORCE AND THE OTHER WEIGHS 150,000 LBS AND IS BEING BRAKED WITH 40% BRAKING FORCE. BY THE SUDDEN EQUALIZATION OF VELOCITY WHEN THE SLACK IS ALL OUT COMPARE THIS STRAIN WITH THE SIMILAR STRAIN EXISTING WHEN THE 150,000 LB CAR IS BEING BRAKED WITH ONLY 10% BRAKING FORCE

ASSUME THAT BEFORE THE SLACK IS ALL OUT, THE CARS HAVE A DIFFERENCE OF VELOCITY OF 1 M.P.H. WHICH HAS COME ABOUT BECAUSE OF THE DIFFERENT RATES OF RETARDATION OF THE TWO CARS LET THE VELOCITY OF THE LOADED CAR BE 20 M.P.H SO THAT THE VELOCITY OF THE EMPTY CAR IS 19 MPH BY FORMULA (5) $V = 1.47 V_m$ 20 MPH $= 20 \times 1.47 = 29.40$ FT PER SEC AND 19 MPH $= 19 \times 1.47 = 27.93$ FT PER SEC. SUBSTITUTING IN FORMULA (3) $MV + M_2V_2 = M'V'$ $\frac{40,000}{32.2} \times 27.93 + \frac{150,000}{32.2} \times 29.40 = \frac{40,000 + 150,000}{32.2} \times V'$ FROM WHICH $V' = 29.0905$ FT PER SEC. THE EMPTY CAR HAS CHANGED ITS VELOCITY FROM 27.93 FT PER SEC TO 29.0905 FT PER SEC THE FORCE NECESSARY TO PRODUCE THIS ACCELERATION IS FOUND BY SUBSTITUTING IN FORMULA (4) $Ft = M_1V' - M_1V_1$ $Ft = \frac{40,000}{32.2} \times 29.0905 - \frac{40,000}{32.2} \times 27.93 = 1439$ IF $t = .1$ SEC THEN F THE DRAW BAR STRAIN WILL EQUAL $1439 \div .1 = 14,390$ LBS

FOR THE SECOND CASE, BY SUBSTITUTION IN FORMULA (5) $\frac{P_1 - P_2}{P_1 - P_2'} = \frac{V_1 - V_2}{V_1 - V_2'}$ $\frac{60-40}{60-10} = \frac{20-19}{20-V_2'}$, $V_2' = 17.8$ MPH BY THE SAME PROCEDURE AS IN THE FIRST CASE, WE FIND THE DRAW BAR STRAIN TO BE 31,657 LBS

L-20

Fig. 28.

Assume a train consisting of 80 cars, 50 loads in front and 30 empties in the rear, the cars being similar to those of Fig. 24. It is impossible to calculate the precise effect due to additional cars besides the two which it is assumed eventually take up the slack. The effect of these cars will lie, however, somewhere between two limits, one of which is when they have no effect and the other is when they have the greatest possible effect, that is, all the loads act as one enormous loaded car and all the empties as one empty. While such limits can never be attained in service, their use enables limiting values of the draw-bar strain to be fixed.

For the first limiting conditions by the methods of Figs. 27 and 28, the draw-bar strain will be 31,657 lbs. and for the second 1,039,010 lbs. That is, the value of the draw-bar strain will lie between 31,657 and 1,039,010 lbs. This makes evident the reason why it is impossible to prevent break-in-twos in long freight trains, the cars of which are equipped with standard brakes. While a strain of 31,657 lbs. probably would be withstood, a strain of 1,039,010 lbs. would result in a break-in-two. In connection with these figures, it should be remembered that

they are obtained by a simplified solution as a rigid mathematical solution is precluded by the physical factors involved.

With less than full service brake pipe reductions, the strains will be correspondingly less, though probably not in direct proportion to the reduction. Conditions may be worse, however, because of the likelihood of the lighter reductions occurring at lower and therefore more critical speeds. Since an absolute uniformity of rate of retardation on all cars in a train would eliminate all possibility of the slack in the train running in or out, it follows that a practicable approach to such an ideal condition, sufficient to prevent rough handling, break-in-twos and damage to lading and equipment due to unequal brake action, will reduce operating expenses, minimize loss and damage accounts and expedite traffic.

(b) *The increased emergency stopping power* resulting from the increased effectiveness of the empty and load brake on the loaded car becomes a consideration when it is remembered that heavily loaded freight trains are often run at fairly high speeds with only one-fourth to one-sixth the braking force available on passenger cars. While the risk to life which is involved is not so great, this, as well as the lading and equipment risk cannot be ignored when the stopping power on a given car is reduced, due to lading alone, to about one-fourth its original calculated amount.

ADEQUATE RETARDING FORCE AND ABILITY TO STOP ON GRADES.

The ability to control the speed of trains down grades without the use of hand brakes, without overtaxing the capacity of any individual units in the train and with a sufficient reserve ready for a reasonably short stop if required, involves the following factors. The accelerating force, due to grade alone is 20 lbs. per ton per cent grade. On a 2.3 % grade this would amount to 46 lbs. per ton average resisting force required to prevent a car from gradually gaining in speed when descending the grade.

From Fig. 21 the percent braking force obtained with a full service reduction, empty car, is 60%. This is equivalent to a total "nominal" brake shoe pressure of $54000 \times .60 = 32400$ pounds, which, assuming 85% brake rigging efficiency and 15%

average coefficient of brake shoe friction for the entire grade, would amount to an actual average service retarding force of $32400 \times .85 \times .15 = 4131$ lbs., or 153 lbs. per ton weight. This being the maximum retarding force derived from a full service reduction, some allowance must be made for repeated releases and re-applications and as the pressure retaining valves will assist in maintaining a high average brake cylinder pressure for such repeated cycles of brake operation it will be making all possible allowance even with the best maintenance to assume that not more than three-fourths full service pressure, or, say, 115 lbs. per ton weight will be available as average retarding force. This is well in excess of the 46 lbs. per ton necessary for a safe control of the train on a 2.3% grade, and consequently the *empty* car has ample reserve for safe control or stopping on such a grade.

But consider the fully loaded car weighing 208,000 lbs. and with "standard" brake equipment. The maximum service retarding force is, as before, 4131 lbs., since the brake equipment remains the same as figured for the empty car.

This is but 40 pounds per ton for the loaded car, or 6 lbs. per ton *less* than required to prevent the loaded car increasing its speed down the grade. If an average retarding force of ¾ full service pressure be assumed as before, there would be but 30 lbs. per ton resisting force available, which is only about ⅔ what is required for constant speed. Taking 20 lbs. per ton per percent grade as the accelerating force due to the grade and 30 lbs. per ton as the highest average retarding force that can be continuously depended upon, when using the standard form of air brake equipment, it follows that the steepest grade on which the fully loaded car weighing 208,000 lbs. could be safely controlled is 1½%. This means that on any grades over 1½% one or more (and generally more) of the following expedients must be resorted to:

(a) Increase the brake pipe pressure and use more air in making correspondingly heavier applications.

(b) Use enough empty cars along with the loads to furnish the necessary additional braking force.

(c) Use hand brakes "clubbed" to a heavy application.

(d) Reduce the speed or tonnage of the train to a safe minimum.

All of the above requires expense and limitation of traffic, perhaps indirect and not always apparent, but none the less real.

With the empty and load brake on the other hand, the total "nominal" brake shoe pressure on the loaded car is 208,000$\times$.40=83200 lbs., which, with the same assumptions as before is equivalent to an actual maximum service braking force of 83,000 $\times$.85$\times$.15=10582 lbs., or 102 lbs. per ton weight or over twice the amount (46 lbs. per ton) required to hold the speed of the car constant.

Assuming three-fourths of this as average and continuously available retarding force, there results 77 lbs. per ton, which is nearly 70% more retarding force than is theoretically required to hold the speed of the car constant.

Supposing the full 102 lbs. per ton to be utilized, the loaded car could be stopped on the grade from a speed of 20 M. P. H. in about 477 feet with the empty and load equipment, whereas, with the standard equipment the car could not be stopped under the conditions assumed, but its speed would continue to increase

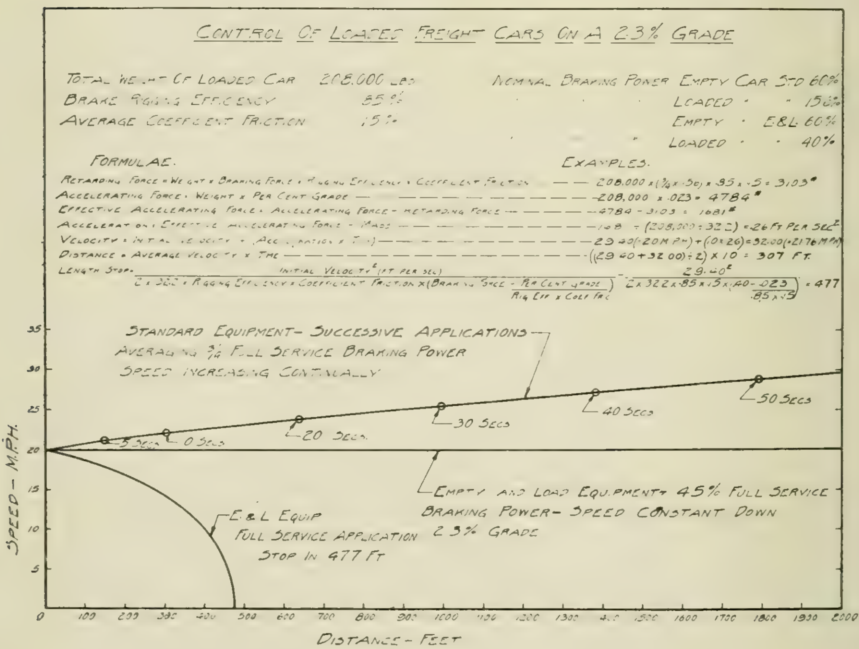


Fig. 29.

until the bottom of the grade was reached or an accident occurred.

Figure 29 shows graphically the comparative effects described above, viz.:

(1) A fully loaded 70 ton car stopped on a 2.3% grade in about 500 feet with a full service brake application, with empty and load brake equipment.

(2) Constant speed down the grade, requiring but an average of 45% of the full service braking power of the empty and load equipment.

(3) Gradual acceleration down the grade with continued reapplications of the old standard equipment.

From the above it is apparent that there must be some means of obtaining a retarding force on the loaded car considerably higher than that affected by the ordinary brake equipment, if it is to be safely controlled down a 2.3% grade. The ample margin of safety afforded by the empty and load brake is evident.

The use of the hand brake set up as tightly as possible and operating continuously down the grade affords only about as much retarding force on the loaded car as that obtained with the standard brake, averaging continuously 50% of full service braking force. Consequently, as far as the loaded car is concerned the hand brake, at its best, could not be relied upon for control on grades, even if the use of the hand brake were recognized as good practice, and the weight to be controlled not beyond the strength of the brakeman.

As an example we submit the following calculations as showing the earning power of the empty and load brake equipment:

Conditions:

Terminal yard, 7½ miles from docks. Freight taken from terminal yard to docks in special trains. Of 7½ miles 6½ is on 2% grade.

50-ton capacity car, empty weight, 20 tons.

Standard equipment, braking force 60% empty weight.

Empty and load equipment, braking force 60% if empty, 40% if loaded.

Yearly tonnage, 13,500,000 tons.

Operating expense, \$1.50 per train mile (includes only transportation, maintenance of way and equipment.)

Mallet locomotives, weight, including tender, 200 tons.

Draw-bar pull locomotive, 93,500 lbs.

Braking force locomotive, 70%.

Train resistance, 6 lbs. per ton at 20 M. P. H.

Acceleration, .15 miles per hour per second.

Standard Equipment:

Allow 40% excess retarding force over that necessary to prevent acceleration on grade.

Then if W=weight train, P=braking force of train

$W \times .02 \times 1.40 = W \times P \times .85 \times .15.$

$P = 22\%.$

$40,000 \times .60 = 24,000$ lbs. cylinder pressure per car.

$400,000 \times .70 = 280,000$ lbs. cylinder pressure locomotive.

If n= number loaded cars.

$$\frac{(24,000 \times n) + 280,000}{(140,000 \times n) + 400,000} = .22$$

$$n = 28$$

That is, there are 28 loaded cars in each train. As the Mallet locomotive can easily start such a train, its tonnage is determined by the ability of the brakes to control it on a grade.

$28 \times 50 = 1400$ tons hauled per train.

$13,500,000 \div 1400 = 9650$ trains per year.

Round trip mileage=15.

Total mileage$=15 \times 9650 = 144,750.$

Total cost$=144750 \times 1.50 = \$217,125.$

Empty and Load Equipment:

Any number of cars can be controlled down grade since 40% braking force is provided while only 22% is necessary.

Length of train will be determined by either (1) ability to haul empty cars up grade, or (2) ability to start loaded train on level.

A grade resistance of 40 lbs. per ton and a train resistance of 6 lbs. per ton makes a total resistance of 46 lbs. per ton.

The locomotive can therefore haul

$93500 \div 46 = 2033$ tons.

$2033 \div 20 = 102$ empty cars per train.

A draw-bar pull of 93,500 lbs. could give an acceleration of .15 M. P. H. per sec. to a mass of $93{,}500 \div (.15 \times 1.47) = 425{,}000$.

A mass of 425,000 equals a weight of 13,700,000 lbs. = 6850 tons.

$6850 \div 70 = 98$ cars (loaded).

Decrease result by 10% to allow for slight grades, etc., and assume 90 cars in loaded train.

$13{,}500{,}000 \div 4500 = 3000$ trains.

Total mileage $= 3000 \times 15 = 45000$.

Total cost $= 45000 \times 1.50 =$ \$67,500.

Conclusion:

Cost transportation with standard brake equipment	\$217,125
Cost transportation with empty and load brake equipment	67,500
Saving per year	\$149,625

Figure 30 will, we believe, impress you very much with the great difference in retarding force, which inherently exists on freight cars, and when added to (that is the effects of the time element and other aggravating conditions), one can readily appreciate why it is necessary to handle the brake on freight trains with extreme care on level track, and on grades with a factor of control.

The curve on Figure 31 gives the limiting grades for various retarding factors.

Figure 32 gives a ready means of obtaining how much the braking force is increased or decreased by change of load in the cars.

With this statement of what has been done in the endeavor to take care of the changed conditions of passenger and freight transportation, as far as we are concerned, we should pass on to the locomotive, but it will suffice to say that the changes in equipment for the locomotive were in the direction of reducing

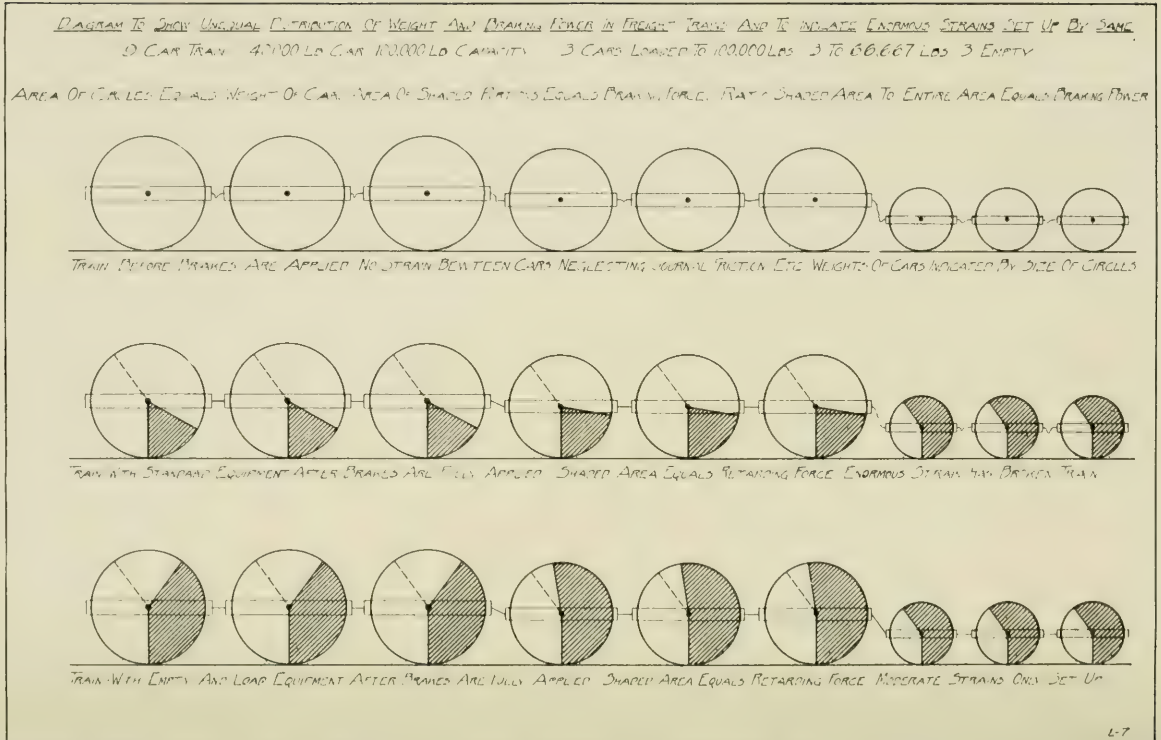


DIAGRAM TO SHOW UNEQUAL DISTRIBUTION OF WEIGHT AND BRAKING POWER IN FREIGHT TRAIN AND TO INDICATE ENORMOUS STRAINS SET UP BY SAME
9 CAR TRAIN 40,000 LB CAR 100,000 LB CAPACITY 3 CARS LOADED TO 100,000 LBS 3 TO 66,667 LBS 3 EMPTY
AREA OF CIRCLES EQUALS WEIGHT OF CAR. AREA OF SHADED PORTIONS EQUALS BRAKING FORCE. RATIO SHADED AREA TO ENTIRE AREA EQUALS BRAKING POWER
TRAIN BEFORE BRAKES ARE APPLIED NO STRAIN BETWEEN CARS NEGLECTING JOURNAL FRICTION ETC WEIGHTS OF CARS INDICATED BY SIZE OF CIRCLES
TRAIN WITH STANDARD EQUIPMENT AFTER BRAKES ARE FULLY APPLIED SHADED AREA EQUALS RETARDING FORCE ENORMOUS STRAIN HAS BROKEN TRAIN
TRAIN WITH EMPTY AND LOAD EQUIPMENT AFTER BRAKES ARE FULLY APPLIED SHADED AREA EQUALS RETARDING FORCE MODERATE STRAINS ONLY SET UP
L-7

Fig. 30.

the number of parts, thereby saving available space, by adding features that gave better control with regard to both maximum force and degree of flexibility, and others, adding greatly to the reliability of action.

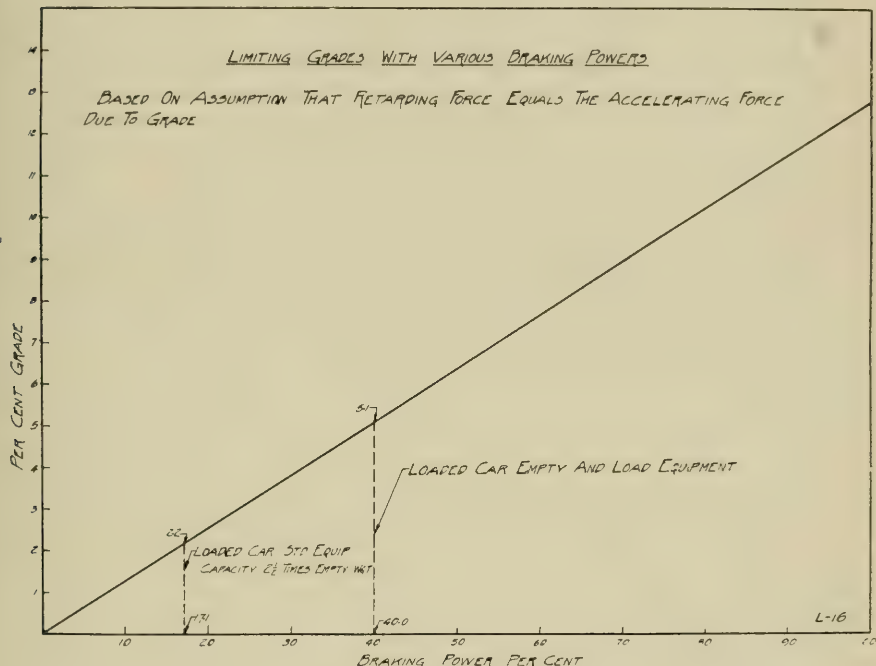


Fig. 31.

OPERATION OF THE BRAKES.

The largeness of the subject and lack of time will not permit dealing at length with the conditions that inherently affect the operation of the brakes, and also from even mentioning all of the wear and tear effects on them.

To illustrate, however, how the brake may become a shock and damage producer, we submit the diagram shown on Figure 33. It is practically impossible to avoid rough handling where such a condition exists as is shown here. While this diagram is largely self-explanatory, it may assist to a quick understanding to say that many trains on the road from which this was taken were composed of cars having the two extremes of force development here given. It will be seen that with a given reduction

the force developed on some cars was vastly greater than on others, and that the very high braking force was obtained with very slight reductions, leaving the engineer no choice between shocks to his train or stuck brakes, either of which is bad. If all

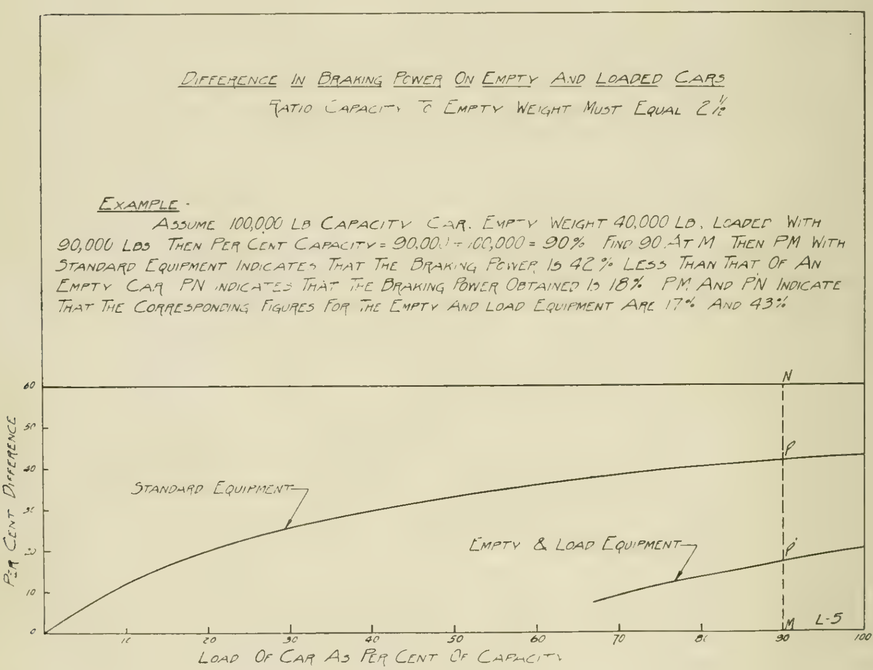


Fig. 32.

the cars were braking properly, that is, as shown by the lower line, it will be seen that a much more flexible and smoother brake inherently existed, while the release of the brakes was assured, because of the fact that a reduction heavy enough to permit this was required, even at low speeds, to obtain the braking force. With a brake that will give the lower line we have an obedient servant, with one that gives the upper line a tyrannical master, one representing gain from its use, the other at least considerable loss.

Figure 34 illustrates the great variation in braking force from unequal piston travel and may be considered as supplementing Figure 33. It should be noted that a 6 lb. brake pipe re-

duction produces 100% greater braking force with a 6 in. travel and 62% less with a 10 in. travel than with an 8 in. travel.

It should also be noted that the force of the brake with the short piston travel remained greatly above the normal for the greater part of the application, while the force of the one with long piston travel remained much below the normal, neither becoming normal or correct for any reduction.

Physical and profile conditions call for discernment and judgment in the manipulation of the brake, but in general we may say that profitable operation will be had and much damage and loss avoided by

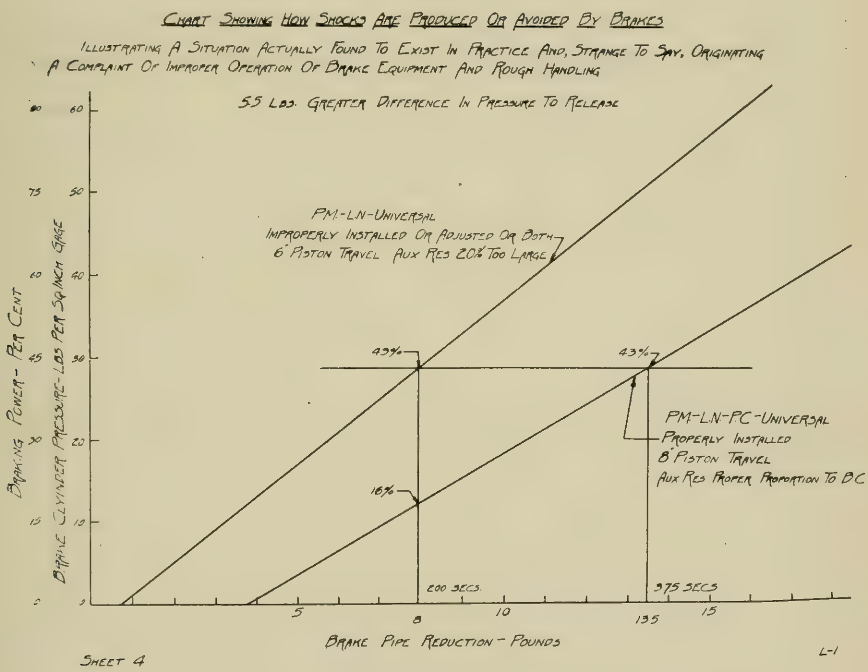


Fig. 33.

(1) Forbidding the use of the straight air brake of the engine to bunch the slack of the train before applying the automatic brake. We are aware that you will quote Westinghouse Instruction Books against this rule, but these instructions, as well as many others, were given to suit conditions very different from those of today. It is a self-evident fact that when conditions change, old rules and instructions become obsolete, or

must be changed to suit the new conditions. A slight review of the instruction regarding the use of straight air to bunch the slack gently, may be sufficient to demonstrate this. This instruction given when only part "air trains" were the rule, was necessary, for if the brakes were applied on the brake cars before the slack was in from the unbraked cars behind, the shock was sometimes equal to a collision. Now, if the slack is bunched with an "all air train," particularly with empties at the rear, the running out of the slack, as the brakes take hold at the rear, often results in a break-in-two and certainly in a shock which is damaging to both equipment and lading.

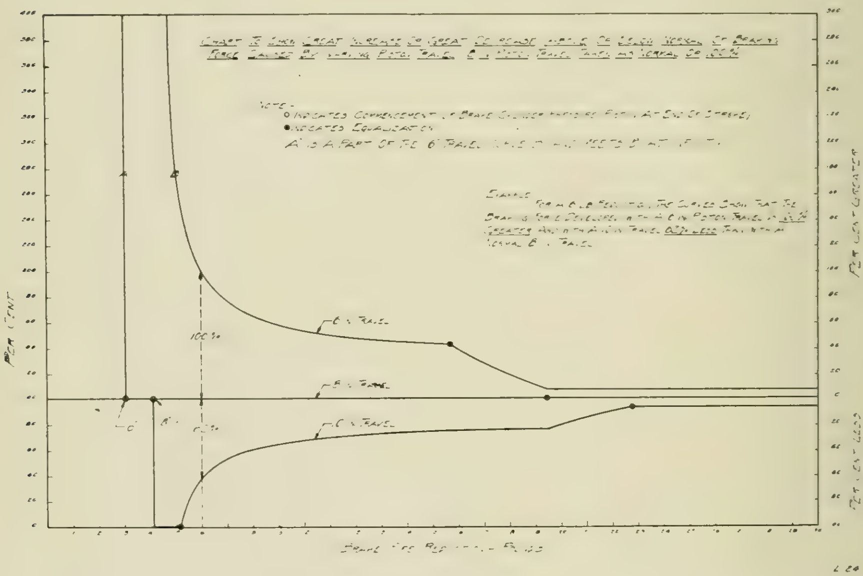


Fig. 34.

We doubt the advisability of using straight air at all for train control, as so much judgment and care is required to use it when and where it will do good and not harm. We mean now for making stops or slow-downs—for if it is applied heavily, a collision is often the result—if applied and released and the throttle opened, while the cars are bunching or still bunched at the rear, a break-in-two is in order. Of course, there are critical speeds and conditions when damage is more likely than at other times. Straight air on the engine is of great value when used

at the proper time and place, but it was not intended to take the place of the automatic brake in controlling trains, nor to be used because *unfair conditions* impair the efficiency of the automatic brake.

(2) By placing loads at the head of the train and shortening the piston travel, and the empties behind and lengthening the piston travel—bringing about a greater difference in cylinder pressure for graduating applications and thereby securing greater equality of braking force between loads and empties; at the same time the emergency pressure will be only slightly altered.

(3) Alternating loads and empties.

(4) Applying the brakes before the slack is bunched as, for instance, before the steam is shut off.

(5) Instructing engineers not to use emergency applications unless actual emergency exists; not, for instance, to consider every switch, water tank, or coal chute as an emergency zone and apply the brakes accordingly.

(6) Not to use heavy initial service reductions, unless speed is low and stop intended.

(7) Do whatever is necessary and possible to secure uniform application of brakes.

(8) Do all possible to insure that it is the engineer that is controlling the application of the brakes and not the brake pipe leakage, and in general that the brakes are maintained in such condition that the anticipated operation is possible and obtained. Give the engineer a chance.

(9) Avoid, if possible, applying or releasing brakes when passing over "hog-backs" or around curves.

(10) Avoid releasing the brakes before the brakes have ceased to apply during a reduction.

(11) Avoid, whenever possible, applying the brakes again after a release, while the brake pipe pressure is higher at the head than at the rear; in other words, equilibrium of pressure should be established throughout the train, as otherwise the head brakes will apply and those at the rear will not—therefore, the cars may be bunched and if the brakes at the next reduction take hold, this in conjunction with the recoil of springs will produce severe shocks.

(12) Avoid releasing brakes at speeds below ten miles per hour, unless the locomotive is equipped with "ET" or the forward cars with "K" triple valves, as otherwise brakes releasing at the head end permit the retardation still existing at the rear to stretch the train—sometimes beyond the strength of the car connections.

(13) Avoid, whenever possible, having too many cars at the rear which are levered for a high braking force, as, for instance, cars (of which there are many in service) upon which the braking force is calculated at 90 per cent on 60 pounds cylinder pressure—it is obvious that this aggravates the already existing inequality of braking force between loads and empties and is in effect the same as attaching so many passenger cars to the rear end of a freight train, which no one who expected smooth operation would do, unless the brakes on these cars were alternately cut out.

(14) Locate the places where accidents of the kind under consideration most often occur and advise extra precautions, for undoubtedly you will find that there are certain track or signal conditions, which, in conjunction with an application or release of the brakes (to say nothing of the starting of trains) tend to produce shocks, and this, added to the already numerous factors tending in the same direction, often result in a "break-in-two. No doubt you will find that a number of your men are cognizant of this fact and have these places pretty well "spotted" and are governed accordingly and, therefore, do not have near the trouble that some others do who either cannot reason back from effect to cause or are careless. To these latter a little information and advice may mean a close approach to the results obtained by others who learn by experience. The writers can illustrate what they mean by this paragraph by calling to your mind how necessary it is that an engineer, new to a division, become acquainted with the track, etc., before the best results can be expected. In other words, other things being equal, his proficiency depends largely upon his knowing the conditions under which he operates.

(15) At speeds of over 20 miles per hour make a light preliminary reduction, followed by continuous heavy reductions, when speed is reduced to, say, 8 miles per hour and stop intended. At low speeds, when stop is intended, make a contin-

uous full reduction. The reason for this is to keep the slack bunched, as the brake will naturally be applying with greater power on the head end than at the rear, therefore tending to keep a steady push toward the engine.

(16) If slow-down only is desired, it is better to make a light reduction, far enough back, than a heavy one to accomplish the same result in less distance. In the former case, when the release is made (even if at slow speed) there should not be braking force enough to cause shock, while in the latter case the reverse is true.

(17) Enforce the rule that with long trains the engine must be cut off from the train whenever an accurate stop is imperative, as for coal and water, and insist that, after again coupling to the train that sufficient time be allowed for the brakes to release before trying to start.

(18) A terminal inspection that will discover and send to the repair track all cars with defects, particularly of draft gear, that are likely to cause trouble on the road. There is no doubt that a great number of break-in-twos are due to defective brakes and draft gear being allowed to leave terminals, and it is hardly a question whether it is wiser to take chances than to adopt a safer method. Of course, it is only a matter of time before the inevitable happens, but each thinks it possible that the car will reach the next terminal. Plainly, as long as chances are taken in these matters, even the best of care on the part of those operating the train on the road, cannot prevent a great many break-in-twos.

As stated, the difference in braking force is held to be the cause of shocks, etc., and the foregoing include at once the reasons why and how it can, in a large measure, be overcome and uniformity more closely approached. It is plain that to do this involves both effort, expense and inconvenience, but this is unavoidable in railroad operation, and we may say that in the matter under consideration, what has been outlined permits of a choice between what *exists* and *what we desire*, to determine which the benefits versus the cost will be the governing consideration.

The following formulae and examples are inserted in order that those concerned may satisfy themselves as to whether the engineering requirements stated are warranted or not. Until

recently air brake engineering consisted almost entirely of statements and opinions, but your orators in all addresses delivered by them have endeavored to deduce air brake engineering to a science, or failing this to at least show the physical factors involved. We have taken this opportunity to insert these formulae not only for this reason but also because we frequently receive requests for them and believe that in this way they will gain a larger circulation than would otherwise be possible. These formulae are fundamental in air brake calculations and should afford sufficient information to anyone to enable him to use them readily. The formulae and examples, shown in Figs. 35 to 43 inclusive, should be self-explanatory.

FORMULAE USED IN BRAKE CALCULATIONS

$$E = FS \qquad (1)$$

$$E = \tfrac{1}{2}MV^2 \qquad (2)$$

$$F = WPef \qquad (3)$$

$$S = \frac{V^2}{2gPef} \qquad (4)$$

$$A = WG \qquad (5)$$

$$P_1 = \frac{G}{ef} \qquad (6)$$

$$S_1 = \frac{V^2}{2gef(P-P_1)} \qquad (7)$$

$$p = g(G - Pef) \qquad (8)$$

E = Kinetic Energy, Ft Lbs
F = Retarding Force, Lbs
S = Length Stop, Ft
M = Mass Train
V = Velocity Train, Ft Per Sec
W = Weight Train, Lbs.
P = Braking Power, Per Cent
e = Brake Rigging Efficiency, Per Cent
f = Coefficient Friction
g = Acceleration Of Gravity
A = Accelerating Force Due To Grade G, Lbs
G = Per Cent Grade
P_1 = Braking Power Necessary To Prevent Acceleration On Grade G
S_1 = Length Stop On Grade G, Ft
p = Acceleration Due To Grade G, Ft. Per Sec Per Sec

L-6

Fig. 35.

$E = FS$

E = Kinetic Energy, Ft Lbs
F = Retarding Force, Lbs
S = Length Stop, Ft

This Formula is Based On The Fundamental Assumption That The Work Done in Stopping A Train Equals The Kinetic Energy Stored In The Train At The Commencement Of The Stop.

From Data Obtained in An Actual Stop,

E = 183,100,000 Ft Lbs
F = 142,062 Lbs
S = 1310 Ft

$FS = 142{,}062 \times 1310 = 186{,}100{,}000 = E$

$$\frac{186{,}100{,}000 - 183{,}100{,}000}{186{,}100{,}000} = 1.6\%$$

This is As Close As Can Be Expected From Service Results

L-8

Fig. 36.

$E = \frac{1}{2} MV^2$

E = Kinetic Energy, Ft Lbs
M = Mass = Weight Divided By Acceleration Of Gravity = $\frac{W}{g}$
V = Velocity, Ft Per Sec

Example -

Find The Kinetic Energy Stored In A Train Consisting Of 1 Locomotive Weighing 388 Tons And 6 Passenger Cars Weighing 37,000 Lbs Each, At A Speed Of 58.4 M.P.H.

Weight Train In Lbs = 388 × 2,000 + 6 × 37,000 = 1,598,000 Lbs
Mass Train = 1,598,000 ÷ 32.2 = 49,627
The Velocity V Must Be in Ft Per Sec
To Change M.P.H. To Ft Per Sec Multiply By 1.47 (5280 ÷ 3600 = 1.47)
58.4 × 1.47 = 85.9 Ft Per Sec
$E = \frac{1}{2} \times 49{,}627 \times (85.9^2) = 183{,}098{,}817$ Ft Lbs
E = 183,098,817 Ft Lbs

L-9

Fig. 37.

$$F = WPef$$

F = RETARDING FORCE ACTING ON TRAIN, LBS.
W = WEIGHT TRAIN, LBS.
P = BRAKING POWER TRAIN, PER CENT
e = BRAKE RIGGING EFFICIENCY, PER CENT
f = COEFFICIENT FRICTION.

EXAMPLE:-
FIND THE RETARDING FORCE ACTING ON A TRAIN CONSISTING OF 1 LOCOMOTIVE WEIGHING 388 TONS AND 6 PASSENGER CARS WEIGHING 137,000 LBS EACH WHEN THE BRAKING POWER OF THE ENTIRE TRAIN IS 104.6 %

WEIGHT TRAIN IN LBS. = $W = 388 \times 2000 + 6 \times 137000 = 1598{,}000$ LBS.
BRAKING POWER, PER CENT = $P = 1.046$
BRAKE RIGGING EFFICIENCY = $e = .85$ AVERAGE VALUE FROM TESTS.
COEFFICIENT FRICTION = $f = .10$ AVERAGE VALUE FROM TESTS

RETARDING FORCE = $F = 1598000 \times 1.046 \times .85 \times .10 = 142{,}062$ LBS

$F = 142{,}062$ LBS.

L-10

Fig. 38.

$$S = \frac{V^2}{2gPef}$$

S = LENGTH STOP, FT
V = INITIAL VELOCITY TRAIN, FT. PER SEC.
g = ACCELERATION OF GRAVITY = 32.2 FT PER SEC. PER SEC.
P = BRAKING POWER ENTIRE TRAIN, PER CENT
e = BRAKE RIGGING EFFICIENCY, PER CENT.
f = COEFFICIENT FRICTION

EXAMPLE:-
FIND THE DISTANCE IN WHICH A TRAIN CAN BE STOPPED FROM A SPEED OF 58.41 M.P.H. WITH A BRAKING POWER OF 104.6 %

V MUST BE IN FT. PER SEC.
TO CHANGE M.P.H. TO FT. PER SEC. MULTIPLY BY 1.47 $\left(\frac{5280}{3600} = 1.47\right)$
$V = 58.41 \times 1.47 = 85.9$ FT. PER SEC.
P = BRAKING POWER = 1.046
e = BRAKE RIGGING EFFICIENCY = .85 AVERAGE VALUE FROM TESTS.
f = COEFFICIENT FRICTION = .10 AVERAGE VALUE FROM TESTS.

$$S = \frac{(85.9^2)}{2 \times 32.2 \times 1.046 \times .85 \times .10} = 1288 \text{ FT.}$$

$S = 1288$ FT.

L-11

Fig. 39.

$$A = WG$$

A = Accelerating force due to grade G, lbs
W = Weight, lbs
G = Per cent grade

Example:–

Find the accelerating force acting on a car whose total weight is 140,000 lbs when the car is on a grade of 1.5%

$W = 140{,}000$
$G = .015$

$$A = WG = 140{,}000 \times .015 = 2100 \text{ lbs.}$$

$$A = 2100 \text{ lbs.}$$

L-12

Fig. 40.

$$P_1 = \frac{G}{ef}$$

P_1 = Braking power necessary to prevent acceleration on grade G.

G = Per cent grade
e = Brake rigging efficiency, per cent
f = Coefficient friction

Example:–

Find the braking power necessary to prevent a car whose total weight is 150,000 lbs from accelerating on a grade of 1.5%.

$G = .015$
$e = .85$ average value from tests.
$f = .15$ average value from tests.

$$P_1 = \frac{G}{ef} = \frac{.015}{.85 \times .15} = .117$$

$$P_1 = 11.7\%$$

L-13

Fig. 41.

$$S_1 = \frac{V^2}{2gef(P-P_1)}$$

S_1 = LENGTH OF STOP ON GRADE G, FT
V = INITIAL VELOCITY TRAIN FT PER SEC.
g = ACCELERATION OF GRAVITY = 32.2 FT PER SEC PER SEC
e = BRAKE RIGGING EFFICIENCY, PER CENT
f = COEFFICIENT FRICTION
P = BRAKING POWER TRAIN, PER CENT
P_1 = BRAKING POWER NECESSARY TO PREVENT ACCELERATION ON GRADE $G = \frac{G}{ef}$

EXAMPLE:-

FIND THE DISTANCE IN WHICH A TRAIN CAN BE STOPPED FROM A SPEED OF 30 MPH ON A GRADE OF 1.5% IF THE BRAKING POWER OF THE ENTIRE TRAIN IS 20%

V MUST BE IN FT PER SEC
TO CHANGE MPH TO FT PER SEC MULTIPLY BY 1.47 $\left(\frac{5280}{3600} = 1.47\right)$
$V = 30 \times 1.47 = 34.1$ FT PER SEC.
$g = 32.2$
$e = .85$ AVERAGE VALUE FROM TESTS.
$f = .15$ AVERAGE VALUE FROM TESTS
$P = .20$

$$P_1 = \frac{G}{ef} = \frac{.015}{.85 \times .15} = .118$$

$$S_1 = \frac{(34.1)^2}{2 \times 32.2 \times .85 \times .15 \times (.20 - .118)} = 1728 \text{ FT.}$$

$$S_1 = 1728 \text{ FT}$$

L-14

Fig. 42.

$$p = g(G - Pef)$$

p = ACCELERATION DUE TO GRADE G, FT. PER SEC PER SEC
g = ACCELERATION OF GRAVITY = 32.2 FT PER SEC PER SEC
G = PER CENT GRADE
P = BRAKING POWER, PER CENT
e = EFFICIENCY BRAKE RIGGING, PER CENT
f = COEFFICIENT FRICTION

EXAMPLE:-

FIND THE ACCELERATION RESULTING FROM A TRAIN WHOSE BRAKING POWER IS 8% DESCENDING A 1.5% GRADE

$G = .015$
$P = .08$
$e = .85$ AVERAGE VALUE FROM TESTS
$f = .15$ AVERAGE VALUE FROM TESTS

$$p = 32.2\left(.015 - (.08 \times .85 \times .15)\right) = .155 \text{ FT PER SEC PER SEC}$$

$$p = .155 \text{ FT PER SEC PER SEC}$$

L-15

Fig. 43.

In conclusion, it may be well to state that the cause of break-in-twos may be traced to the method of handling the brakes—to the condition and class of draft gear and brake equipment—to the make-up of the train and the kind of train service —it being understood that the human equation is a qualifying factor at all times. All these causes taken singly or collectively are such at times as to make a break-in-two difficult if not impossible to avoid.

"Break-in-twos" are caused by greater braking force at the rear than at the forward part of the train. This class of break-in-two often causes much inconvenience and some loss, but as it is a separation and not a collision, the danger of serious accident is not great, unless following trains are too close.

"Buckling" is caused by greater braking force at the forward end of the train than at the rear. This occurrence not only means inconvenience and loss, but the danger of serious accident to both the train to which it occurs and to others of either direction is very great, as the cars may be scattered over the different tracks.

We have gone into this part of the subject somewhat fully, if not completely, because we should at least do so sufficiently to permit of your weighing both sides of the question.

The number of things mentioned show the complexity of the problem and many may say that no one can take all these things into consideration. This may be so, but they exist and must be dealt with as a condition and not a theory, and in proportion as they are taken into consideration will improvement be made, and, what is also important, the responsibility will be placed where it belongs, which is the first step toward desired results.

It will be seen that there are four elements involved in every brake operation, namely: First, time; second, amount of reduction or change of pressure in the brake pipe; third, amount of cylinder pressure obtained, and, fourth, percentage of braking force. Only one of these is fixed, viz.: the percentage of braking force. That is, a given pressure in the cylinder gives a certain braking force; all the rest are variable. For instance, the time required to reduce the brake pipe pressure a certain amount is varied by increasing or decreasing the length of the train because this changes the volume of air in the brake pipe. The amount of reduction required to obtain a given cylinder pressure

is varied by the ratio of the reservoir to the brake cylinder and the cylinder pressure obtained from a given decrease in reservoir pressure is varied by the ratio of the brake cylinder to the reservoir, which ratio is varied by an increase or decrease of piston travel, as this in effect increases or decreases the size of the brake cylinder. Plainly, then, all these elements must be kept in mind when considering any problem involving train control and it is only by knowing the relationship existing between the different elements that the cause of the results obtained can be deduced.

The control of trains has become a much more complicated problem than heretofore, much knowledge of all the conditions involved is necessary, and the best talent available will be taxed to the limit to get the most economical efficiency, and yet, strange as it may seem, these things are realized only by the few.

The air brake has advanced in the past few years from being considered chiefly a safety appliance that was required by the law to be applied, to an absolute necessity in the handling of freight and passenger trains, but its purpose and its operation must be properly understood to make it a dividend-earning asset.

By this analysis may you be persuaded to (1) instal an air brake of modern efficiency, (2) to instruct those concerned in its use, as to its principles and the conditions to be considered, and (3) insure that its maintenance is such that its good effects can be obtained and its bad ones prevented. If these things are done, great gain in road and equipment results are assured without offsetting loss and damage, and last, but not least, safety will be raised to its highest plane.

PRESIDENT: Mr. P. H. Donovan, we would like to hear from you.

MR. DONOVAN: Mr. President, I hardly think it is necessary for me to say anything. Mr. Turner is capable of handling the paper all the way through, and I know it would not be satisfactory for me to try to answer the questions, so I will leave that to Mr. Turner.

PRESIDENT: We will take a few minutes more time if there are any questions to be asked.

MR. J. C. WARNE: I would like to know from Mr. Turner how he obtained that 200,000 capacity car?

MR. TURNER: That is one of the B. & O. cars. I think they have a large number, not only the B. & O. but the Norfolk and Western, and there are a number of them in operation.

MR. WARNE: A 70-ton car?

MR. TURNER: Weigh 54,000 pounds, and 70 tons is 140,000 pounds. A 10% overload makes over 200,000 pounds. There are many in use now.

PRESIDENT: Are there any other questions to be asked? I saw Mr. Alexander in the room the early part of the evening.

MR. J. R. ALEXANDER: Mr. President, I believe Mr. Turner has passed over all the thoughts that I have, and a great many more, better words than I could express, and I think the best compliment I can pay myself is to keep quiet.

PRESIDENT: Mr. D. J. Redding.

MR. REDDING: I cannot think of anything I could say that would add to the gaiety of the occasion.

PRESIDENT: Any more questions to be asked? If not, we will hear from Mr. Turner in closing.

MR. TURNER: I thank you very much, gentlemen, for being here tonight. I am sorry we had such a delay and the paper was so long, but the fact of the matter is, I have not had time to cut the paper down; I have been so busy I didn't have time. I thank you very much for your attention.

MR. REDDING: Mr. President, I think I voice the sentiments of this audience when I say that we have listened to one o fthe very best papers that has ever been presented to this Club; that is, one containing more solid benefit and more than one can get benefit from in reading than in any other I have heard. I want to express the thanks of the audience to Mr. Turner.

The motion of Mr. Redding, that the thanks of the Club be tendered to Mr. Turner for his very able paper, being duly seconded, was put to vote and carried.

Meeting adjourned.

J. B. Anderson

Secretary.

OFFICIAL PROCEEDINGS OF

RAILWAY CLUB OF PITTSBURGH

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RAILWAY SIGNALING

By MR. A. H. RUDD, SIGNAL ENGINEER
PENNA. R. R., PHILADELPHIA, PA.

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OFFICIAL PROCEEDINGS

OF

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, MAY 23rd, 1913.

The regular monthly meeting was called to order at 8 P. M. at the Monongahela House, Pittsburgh, Pa., by President A. G. Mitchell.

The following gentlemen registered:

MEMBERS.

Ackenheil, J. D.
Allison, John
Anderson, J. B.
Backoski, Jos. G.
Barth, John W.
Battinhouse, J.
Bealor, B. G.
Berghane, A. L.
Bond, W. W.
Brandt, E. K.
Breese, E. W.
Bugle, Geo.
Byron, A. W.
Cain, C. C.
Chittenden, A. D.
Clark, C. C.
Cole, Joshua T.
Cooper, F. E.
Cotton, A. C.
Coulter, A. F.
Courtney, D. C.
Dalton, C. R.
Detwiler, U. G.
Gillespie, W. J.
Gray, T. H.
Gumbes, J. H.
Hair, H. J.
Hardman, H. J.
Harriman, C. A.
Hays, M. O.
Hench, N. M.
Hoffman, C. T.
Howe, D. M.
Howe, H.
Hudson, W. L.
Hurley, Theo.
Kinch, L. E.
King, Wm. R.
Kissinger, C. F.
Keiser, John
Kelly, H. B.
Knickerbocker, A. C.
Lewis, A. J.
Lobez, P. L.
Long, R. M.
Longnecker, John S.
Lynn, Saml.
MacQuown, H. C.
Maxfield, H. H.
Mitchell, A. G.
Montague, W. T.
McCauley, Wm.
McGough, M. F.
McKeen, J. W.
McNulty, F. M.
McNaight, A. H.
Neal, John T.
Newbury, E. H.
Newman, L. L.
Oates, Geo. M.
Overly, C. F.
Painter, Joseph
Parks, F. H.
Pierce, H. B.
Porter, H. T.
Proven, John
Postlethwaite, C. I.
Pyle, P. S.
Rea, C. S.
Reymer, C. H.
Richers, G. J.
Richey, C. W.
Riddell, W. J.
Rohn, W. B.
Robbins, F. S.
Ryan, Wm. F.

Scheck, H. G.
Shallenberger, C. M.
Shannon, Chas.
Sherman, J. K.
Shook, A. A.
Shook, S. D.
Sinclair, C. F.
Smith, F. W. Jr.
Smith, John B.
Smoot, W. D.
Stewart, S. R. B.
Stucki, A.
Suhrie, N.
Taylor, F. C.
Thurber, Guy P.
Towson, T. W.
Tucker, J. L.
Walter, W. A.
Walther, G. C.
Ward, R. H.
Warne, J. C.
White, F. L.
Wills, Jas. F.
Wiseman, E. B.
Wood, Ralph C.
Wyke, J. W.

VISITORS.

Agnew, C. G.
Bean, Wm. E.
Bradley, W. C.
Braun ,F. R.
Braun, A. C.
Braun, L. H.
Blanchard, W. E.
Burnett, Geo. H.
Butzler, C. A.
Carroll, F. E.
Canon, G. S.
Chapman, B. D.
Clawson, J. E.
Coe, Robert
Crawford, A. M.
Dickinson, J. Z.
Evans, H. C.
Eyman, Fred.
Feather, J. L.
Ferre, W. J.
Foltz, E. F.
Gray, A. E.
Grieve, R. E.
Hagen, E. F.
Hasiba, W. T.
Hykes, W. H.
Keener, W. A.
Keyser, R. H.
Lergenmiller, H. M.
Mattis, H.
Minton, J. H.
Morgan, D. G.
McKelvey, F. A.
O'Donnel, R. L.
Parke, R. A.
Pollock, A. B.
Putney, F. C.
Raymer, I. S.
Ridley, R. C.
Shondel, J. C.
Smith, Thos. B.
Snyder, J. W.
Springer, F. E.
Sproule, T. L.
Stewart, John F.
Sweeney, E. H.
Trappe, W. C.
Treiber, J. W.
Williamson, A. G.
Wittig, Wm.
Wrenn, C. G.
Yawman, C. A.

The roll call was dispensed with, this being supplied by the registration cards.

The reading of the minutes was dispensed with, as the minutes were already in type and about ready for mailing.

The Secretary read the following list of applications for membership:

Albert, Leon H., Traveling Fireman, P. R. R., Elrama, Pa. Recommended by H. G Scheck

Braun, A. C., Asst. Supervisor Signals, P. R R., 847 N. Linden avenue, Pittsburgh, Pa Recommended by H. H Maxfield.

Caine, C. D., Foreman, P. R. R., 434 Shady avenue, Pittsburgh, Pa. Recommended by H. W. Lehr.

Conner, W. P., Enginner, P. R. R., Floreffe, Pa. Recommended by H. G. Scheck.

Crawford, Archibald M., Signal Repairman, P. R. R., 641 Collins avenue, Pittsburgh, Pa. Recommended by C. S. Rea.

Dunlap, Albert N., District Manager, the Bird-Archer Co., First National Bank Bldg., Pittsburgh, Pa. Recommended by T. C. Green.

Graff, E. D., Salesman, Jos. T. Ryerson & Son, 2202 Oliver Building, Pittsburgh. Recommended by Wm. C. Schuck.

Kapp, J. B., Asst. Master Mechanic, P. R. R., Oil City, Pa. Recommended by M. O'Connor.

Pollock, A. B., Supervisor of Signals, P. R. R., East Liberty, Pa. Recommended by H. H. Maxfield.

Richardson, R. S., Rep. The Railway Review, Fort Pitt Hotel, Pittsburgh, Pa. Recommended by A. Stucki.

Smith, Thos. B., Asst. Supervisor Signals, P. R. R., Johnstown, Recommended by H. H. Maxfield.

Stevens, Cecil, Sales Agent, American Steel Foundries, 36th street and A. V. Ry., Pittsburgh, Pa. Recommended by H. W. Green.

Thirlkeld, C. M., Traffic Manager, National Fire Proofing Co., Fulton Bldg., Pittsburgh, Pa. Recommended by E. A. Condit, Jr.

Trappe, W. C., Electrician, Penna. R. R. Co., 522 Wallace avenue, Pittsburgh, Pa. Recommended by H. W. Lehr.

Wertz, Peter, Foreman, Dukesmith Air Brake Co., 1610 Juniata street, N. S., Pittsburgh, Pa. Recommended by D. C. Courtney.

PRESIDENT MITCHELL: When the Executive Committee passes favorably upon these applicants they will become members.

The Secretary announced the death of John T. Brown, Vice President and Manager, Damascus Bronze Co., Pittsburgh, which occurred on May 20th, 1913. Mr. Brown was a charter member of the club.

Also George H. Smith, Mechanical Engineer, Carnegie Steel Co., which occurred May 20th, 1913. Mr. Smith was elected a member of the club December 23, 1910.

The President directed that a suitable memorial page be inserted in the minutes on the death of these two members.

PRESIDENT: If there is no further business, we come to the subject of the evening, an address by Mr. A. H. Rudd, Signal Engineer of the Pennsylvania Railroad, on "Railway Signaling."

MR A. H. RUDD: It is usual in an address of this kind to start with Adam and Eve or at least with the flood and work down through, explaining the evolution of signaling and the reasons for the changes, devoting about an hour and three-quarters to these preliminaries, leading gradually to the new system that we have, and then let the audience draw on its imagination for the answer, the time having expired. I have done it and lots of auditors have strayed away. Tonight I want you to stay with me for a few minutes, so I am going to try the experiment of leaving out the primary and secondary and tertiary stages and come right down to the signals which we are now putting in on the Pennsylvania Railroad, and which they are putting on a great many railroads, with some variations. I shall speak of the indications and "aspects" (a word not coined, but discovered in the dictionary by Mr. George W. Snyder, of the P. R. R., which we consider indispensible nowadays). I am going to leave out the home and distant system that is in use on a great part of the mileage of the country today, treating it as if it were obsolete (although it will be many years before it is so), and just tell you of our method of giving information to the enginemen and the means taken to insure the accuracy of such information by the signalmen, and lastly give a brief summary of

the automatic stop situation (the panacea for all our troubles) as I see it.

We have started a new system with certain fundamental principles the first of which is that a signal imperfectly displayed or the absence of a signal at a place where a signal is usually shown, must be regarded as the most restrictive indication that can be given by that signal. We have tried to design the signal so that if it is imperfectly displayed it will show in itself that it is not properly displayed. I will explain that a little later.

The second principle is that a red light or arm horizontal indicates stop unless qualified by a more favorable color or angle of arm. When this scheme was first proposed there was a great deal of opposition to it because it required an engineman to run past a red light in almost every case—in every case, in fact, where a signal indicated a clear block with one exception. It had been done for years with interlocking signals, but we had not done it with automatics and it was thought probably a bad thing to extend the use of the red light to the automatic signals. I think results have proved that it is not much of a mistake. Remember, then, that a red light means stop, unless qualified by a more favorable color indication.

Third: A given aspect conveys the same information at all places, at all times and under all conditions, so that an engineman knowing the physical characteristics of his road and the location of his signals may always be sure that he is obtaining the same information with the same signal aspect.

Fourth: The signal must indicate where and when trains must stop and the action to be taken after stopping—whether or not it indicates the condition of the block and, if it does, whether the block is occupied or clear. It must indicate when to prepare to stop or slow down and how fast trains may run under the changeable conditions at interlockings. It must show in itself when it is properly displayed.

Fifth: This information is all that is needed as to conditions ahead to enable an engineman to run safely confidently and expeditiously if he obeys the indications.

To give this information the signals are divided into four classes—stop, caution, proceed and permissive. The stop sig-

nals are all red. The proceed signals show a white light in combination with red or green. The caution signals show a green light in combination with a red. And the permissive signal shows two horizontal green lights in combination with the red. The permissive signal is probably needed more on the Pennsylvania than on any other road. The great majority of the roads of the country under manual block issue a card to enable the engineman to pass a stop signal to enter an occupied block. We give a signal for it. We do not permit a passenger train to enter an occupied block; we do not permit a freight to enter a block occupied by a passenger train; and this practice has been pretty well extended, so that as a general rule on some divisions preference freight is run under absolute block. We have felt it necessary to indicate to the enginemen of fast trains, which are not permitted to accept a permissive signal, a difference between that signal and an ordinary caution signal. It is a stop signal to them, and it must be different from the ordinary caution (distant) signal, which they can accept. A few roads which do use permissive operation as we use it allow passenger trains to enter the block with the freight under the permissive, and for that reason there is no need for them to make any difference in the signal.

Stop signals are divided into two classes, stop and proceed, and stop and stay. Stop and proceed signals are the ordinary automatics to be passed as per Rule 504, looking out for a train in the block, switch open, broken rail, etc. These are identified by the staggered lights, diagonal lights, with pointed arms. The pointed arm may not be necessary, but the New York Central has used it a long time. In order to get a system which would be uniform on the Pennsylvania and the New York Central and some of the other roads which operate with us jointly we adopted the pointed arm.

The stop and stay signals have vertical lights, either two or three, with square or round end arm, so that when an engineman comes to a signal with a pointed arm at stop he can stop and proceed; if he comes to another with a square or round end arm he knows he must stop until he receives further instructions.

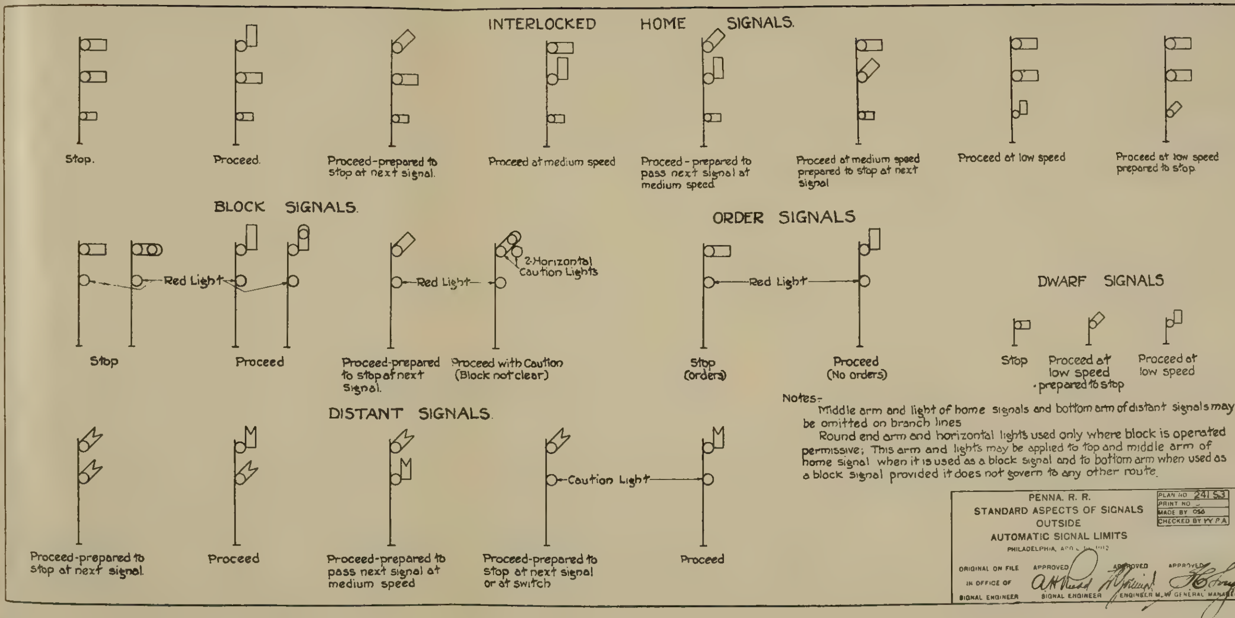
Caution signals are divided into two classes. First, those indicating one block clear, the next signal stop; second, those

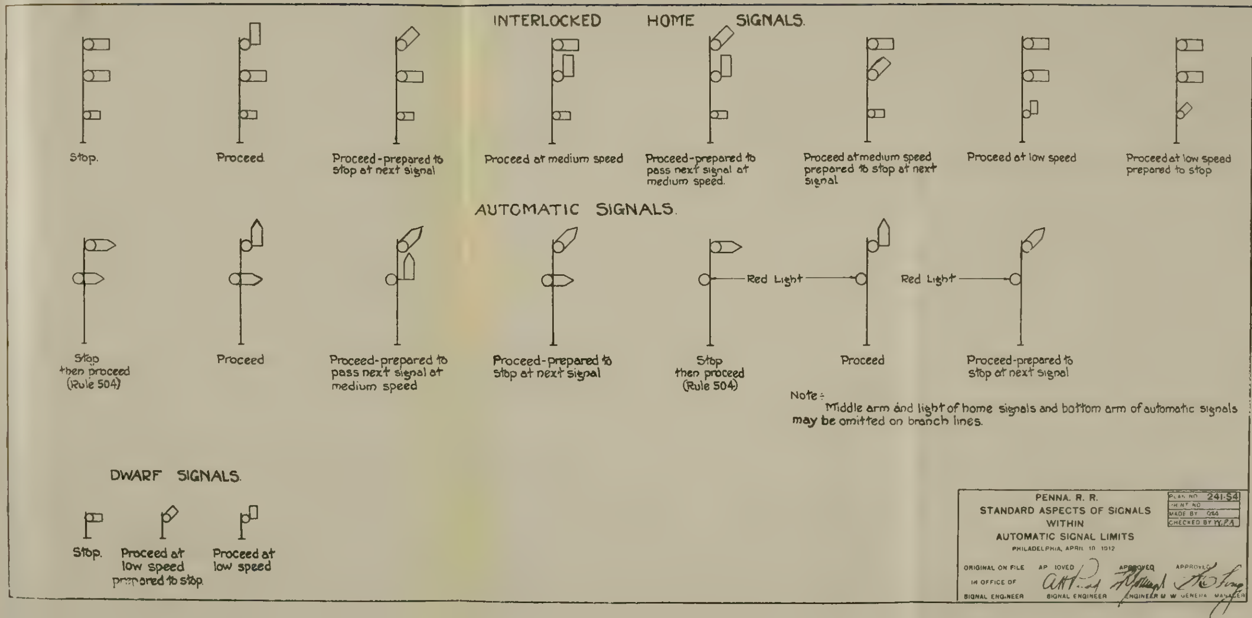
indicating the position of the next signal, but also indicating that they give no information as to the occupancy of the block. In automatic blocks a clear signal indicates that the track is clear to the next home and the next home is clear. In manual block territory under permissive operation you might have a clear distant, but there might be a train between the distant and the home. So that we have added the fishtail arm with vertical green lights. Those signals are distant signals purely and never go to stop and never indicate the position of the block, and therefore they do not show a red light. The rule is that a signal imperfectly displayed or the absence of a signal must be regarded as the most restrictive indication that can be given by that signal. Now if the active light goes out and this signal is a stop signal, the most restrictive indication is stop. Therefore we display a red light with the active light out. With the distant signal the most restrictive indication is caution; therefore we show a green light if the active light is out, so that the signal in itself shows what its most restrictive indication is.

Permissive signals indicate positively to a man that the block is occupied. The clear signals indicate clear track, except the clear fishtail distant, which does not indicate anything about the track. Now clear signals may govern, and do govern, the speed at which trains may pass an interlocking. The top arm is the top speed, the bottom arm is the bottom speed, and the middle arm is the middle speed. In practice the top arm clear governs the authorized speed at that point, the bottom arm clear not to exceed 15 miles an hour, and the middle arm clear not to exceed 30 miles an hour. The old scheme of signaling routes has been abandoned, and we have come to what may be known as speed signals at interlocking, where conditions change on account of the changed position of switches. We do not attempt to signal speed out on the road, where the curvature is fixed and the grades and the stations, etc., are established. But where the conditions change at interlocking we signal the speed.

(Note diagrams next attached.)

The indication "Proceed at slow speed" is given for movements not exceeding 15 miles an hour with traffic when next signal is clear. An aspect with the bottom arm at 45° is what we call the "know nothing" signal, or anything you please. Proceed with extra caution prepared to stop. It may govern to an


INTERLOCKED HOME SIGNALS.
Stop.
Proceed.
Proceed-prepared to stop at next signal.
Proceed at medium speed
Proceed - prepared to pass next signal at medium speed
Proceed at medium speed prepared to stop at next signal
Proceed at low speed
Proceed at low speed prepared to stop
BLOCK SIGNALS.
Red Light
Stop
Proceed
Red Light
2-Horizontal Caution Lights
Proceed-prepared to stop at next Signal.
Proceed with Caution (Block not clear)
ORDER SIGNALS
Red Light
Stop (orders)
Proceed (No orders)
DWARF SIGNALS
Stop
Proceed at low speed - prepared to stop
Proceed at low speed
DISTANT SIGNALS.
Caution Light
Proceed-prepared to stop at next signal.
Proceed
Proceed-prepared to pass next signal at medium speed
Proceed-prepared to stop at next signal or at switch
Proceed
Notes:-
Middle arm and light of home signals and bottom arm of distant signals may be omitted on branch lines
Round end arm and horizontal lights used only where block is operated permissive; This arm and lights may be applied to top and middle arm of home signal when it is used as a block signal and to bottom arm when used as a block signal provided it does not govern to any other route.
PENNA. R. R.
STANDARD ASPECTS OF SIGNALS
OUTSIDE
AUTOMATIC SIGNAL LIMITS
PHILADELPHIA,
PLAN NO 241 S3
PRINT NO
MADE BY OSA
CHECKED BY YY P A
ORIGINAL ON FILE IN OFFICE OF SIGNAL ENGINEER
APPROVED
A H Rudd
SIGNAL ENGINEER
APPROVED
ENGINEER M. W
APPROVED
GENERAL MANAGER



INTERLOCKED HOME SIGNALS.
Stop.
Proceed
Proceed-prepared to stop at next signal
Proceed at medium speed
Proceed-prepared to pass next signal at medium speed.
Proceed at medium speed prepared to stop at next signal
Proceed at low speed
Proceed at low speed prepared to stop
AUTOMATIC SIGNALS.
Stop then proceed (Rule 504)
Proceed
Proceed-prepared to pass next signal at medium speed
Proceed-prepared to stop at next signal
Red Light
Red Light
Stop then proceed (Rule 504)
Proceed
Proceed-prepared to stop at next signal
Note:- Middle arm and light of home signals and bottom arm of automatic signals may be omitted on branch lines.
DWARF SIGNALS.
Stop.
Proceed at low speed prepared to stop.
Proceed at low speed
PENNA. R. R.
STANDARD ASPECTS OF SIGNALS
WITHIN
AUTOMATIC SIGNAL LIMITS
PHILADELPHIA, APRIL 10 1912
PLAN NO 241-54
ORIGINAL ON FILE IN OFFICE OF SIGNAL ENGINEER
APPROVED SIGNAL ENGINEER
APPROVED
APPROVED

occupied track, it may govern against traffic over a short cross-over; at any rate, it indicates that you may pass the stop signal above it, which governs the through movement, but you must look out for yourself.

The dwarf signals govern the same way as low-speed signals—stop; proceed with caution, looking out for anything ahead; and proceed with traffic, your next signal is clear.

The fishtail signals do not indicate the condition of the block.

You will notice that they are all consistent, they all display a red light in combination with others, where they indicate block conditions, except the one with the green over white, and that bothers more people than anything else in the signal business. It is a poor aspect, it is inconsistent. But it is the best we can get. It is a pretty valuable signal on the P. R. R. The Lines West do not use it; they claim they do not need to use it. A great many others do not. The Pennsylvania does and the New York Central does, and I believe the B. & O. does.

This system as it stands I believe will remain unchanged on the Pennsylvania Railroad for a considerable time. Experience has shown that it is all we need, except for some few changes which I hope they will let us make. We have adopted a purple light to show the siding derail open. Some years ago the General Manager issued instructions that switch lights on sidings and in yards should not be red, that they were liable to confuse the main line runners; and that left us when we came to study it only one color to use for derails, and that was purple. It is a short-range light, similar to red, and yet it cannot be mistaken for it.. We still have the red for the dwarf signal light next to the main track, governing movements against traffic on the main track and to the main track from sidings and yards. I hope some time to see these changed to purple, removing all low red lights except on main line switches.

And I have another "hobby," and that is green for clear and yellow for caution. A good many railroads in the country have adopted it, and to my mind it has very decided advantages over the present practice. That is where we have a white light in our diagrams substitute green, and where we have a green light substitute yellow, making in that case the yard lights yellow and lunar white and the main line switch lights red and

green, so there will be no confusion to main line runners with any siding switch light.

Our Lines West and a good many of the western roads omit the middle arm and just have two arms, using the top arm as shown in these drawings, and the second arm at 45° for low speed and vertical for medium speed. I do not see how any road that still has a home and distant signal can adopt that, because the home and distant signals show red and green, and that would mean the same as proceed at low speed. The green light in the stop signal must be eliminated before any road can adopt the simplified two-light system all the way through. But that is ideal, to have two lights and never less than two. Then if an engineman comes to a one-light signal he knows it is improperly displayed. At present with us he knows that if he gets one light on a signal it is improperly displayed. All the automatics have two lights, all the distant signals and manual blocks have two lights, and at certain interlockings he has three, and the fact that there are three there is shown him by the display of two arms on the distant signal, so where he comes to a two-arm distant signal he knows the next signal is a three-light signal. It helps the engineman to determine whether he has a light out at the home, and when the system is well learned there will not be very many enginemen running by signals because there is a light out.

We also have slow and stop boards and track tank signs showing lunar white and green. Then we have the coon tail. The coon tail is a very valuable adjunct to a coon. It is a very valuable adjunct to us in spots. We issue instructions that a man should slow down and then we put a coon tail up to show him where he should slow down. It is quite a good deal of assistance in marking slow points along the road.

As to the means taken to insure the accuracy of the indications, we are installing all our new automatic work with alternating current track circuits, because we find that power and current from trolley road lines interferes with our direct current track circuits. There are precautionary measures that can be taken with D. C. circuits, such as double relays and cutting circuits up, which have been tried with fair success. The real cure for the foreign current is the A. C. track circuit, and we are not only installing all new work that way, but changing over

some of the old. This carries with it electric lights on the signal and A. C. motors.

The cost of installation is heavy. It runs for double track about $3,000 per block, 4,000 or 5,000 or 6,000 feet long; for the two tracks probably $8,000 a mile. I suppose some of the expense end of that will come out of the 5% advance in rates!

Operating and maintenance costs are below anything we have had. The electro-pneumatic signal runs about $160 a year per block. That on a four-track road is $640 a mile. The D. C. motor runs about $90, and in some fortunate cases we have had $75 quoted, but we are from Missouri. The A. C. runs not over $60. That means a saving of $400 a mile over the old electro-pneumatic. While it is more expensive than the D C. motor, when the difference in cost of installation is considered, we think it is safer.

People do not appreciate the money the railroads are spending on signals today. They see these foolish-looking arms flopping up and down, but they do not appreciate what it costs to operate them and what they mean. There are so many other things we ought to spend our money for that they seem to overlook the signals somewhat. On the single track in places we are using what we call the controlled manual block, where we have a stretch of single track in a double-track line and the track is pretty hot and we have had to issue a great many orders, we put in this controlled manual with the track circuit, so that both the signalmen and the track circuit have to go wrong and the trains go wrong also before we can get them together, and we are moving the trains in such places without orders to the trains and saving a great deal of delay. The delay of holding freights for orders often knocks them out of their running time and holds them back an hour or two. With this scheme they can skin through without time table rights, but simply on signal, and a great deal of delay is saved. We are using it on a third track in some places, and we are contemplating putting it on the two inside tracks in our four-track line in a few places so we can handle three tracks in one direction under signal during certain parts of the day, and in the other direction during other parts of the day.

Now everybody understands about interlocking. The Standard Code defines it as an arrangement of switches, lock and

signal appliances so interconnected that their movements must succeed each other in a predetermined order. In ordinary language it means that the levers are so hitched up that you have got to set up the route properly before you can clear your signal, and after you clear it you cannot change the route until you put the signal back to stop again. That is all right as far as it goes. But after you put the signal back you can change the route with the ordinary interlocking. You can change a switch ahead of a train; you could move it under a train except that at the switch they have a detector bar which rises outside of the rail and strikes the wheel and prevents the changing of the switch until the car has passed over it. The detector bar is not wide enough to sustain the pressure on it with power interlocking and sometimes fails under the train. So we installed electric switch locking so that when the train is on the switch it could not be moved. The train shunted the circuit and locked up the lever. Then we extended it to take in the fouling points. Then we extended it to lock the switches ahead. So that even if the switchman put the signal normal the switch would be locked until after the train passed over.

That was all right if you ran in one direction. When we tried to run the train in the other direction we could lock them up, but the switch fartheset ahead that we did not want to unlock was the first one to unlock, and those we wanted to unlock first were the last to unlock. Mr. Anthony, Assistant Signal Engineer, Pennsylvania Railroad, solved that problem. After we got the switches locked up we had a case where an engineman reported that he had a clear distant which changed to caution just in front of him. He stopped just short of the home signal and found the train crossing over in front of him. If he had been about six seconds sooner he would have gone into the side of that train. Then we arranged the locking so that when a train entered the circuit 3,000 or 4,000 feet from the distant signal it locked the levers so the signals could be put to stop, but the route could not be changed until he had passed the home signal. That was a long step in advance. To provide for a train shifting we put in a slow release, which took two or three minutes to change the route. If a man consumes three minutes between the distant and home he can stop even if the home is against him. As a substitute we used a time release, so

arranged that after a signal was put normal it would take two minutes to change the route. That means that after the engine has passed it will take two minutes to let him into the siding. Recently we have developed a scheme so that we can use the time lock if the train is approaching, but release as soon as it has passed the home, so we get all the quick release of the approach locking and economy of the time locking.

Now our big four-track interlocking, with all the modern for construction and maintenance $3,700,000 for signal work. for construction and maintenance $3,700,000 for signal work. This year we have $4,200,000 appropriated. It is probable that we will get four or five big interlocking appropriations and then some appropriation for the electrification near Philadelphia. I presume we will have this year over $5,000,000 to spend on signals. That makes you wonder where it all comes from. In talking with an attorney of a Western road a while ago he said he had been before the postal authorities and proved to them that they were losing money carrying their mails; he had been before the Interstate Commerce Commission to plead for higher freight rates because they were losing money on freight. He had shown the State Commissioner of Illinois that they were losing money on the passenger business even at the present rate, and they could not cut down to 2 cents a mile; and he had shown the Express Company people that they were hauling their stuff at a loss. "And yet," he said, "you fellows are declaring dividends ,and if those fellows get together where am I going to be?"

On our Manhattan Terminal, which is the best signalled piece of railroad in the world, we have automatic signals through the tunnels in both directions, and we have automatic stops. The signals are so arranged that by throwing a lever in the big cabin at the Terminal and another at the Hackensack drawbridge, five miles away, we reverse the traffic. If trains have been running west and have passed out of the block we lower all the automatic stops and put them out of business for westbound trans, and throw in service the automatic stops and signals for east-bound trains. We operate two or three trains that way daily in order to be sure that everything is working properly, because if we have one of our tubes blocked we will need it like the Texan needs his revolver—"damn bad." We are

going to be ready for emergencies. That is the only place where we use the automatic stop. Bulletin 63 of the Union Switch and Signal Co., most of whose works they have built out of the profits they have made off the P. R. R., states that the first automatic stop was invented by Mr. A. S. Vogt, of the P. R. R., which consisted of an arm sticking out from the signal and a glass tube on top of the cab, which when struck by the arm was broken, thus opening the train pipe. I think that was in 1889. I remember it well. I went in the signal business in 1888. In 1889 Mr. Vogt's glass tube was put on an engine on the Pittsburgh Division. They did not arm themselves with any substitutes, and when they came through the Gallitzin tunnel an icicle hit the thing and the emergency went on, to the edification of all concerned. I think that was the last time it was used on the P. R. R.

There have been some 2,000 automatic stops invented and over 1,000 patented. The one we are using is the Hill automatic stop. That is comprised of three parts, like all Gaul. The first part was invented by Mr. Kinsman, as near as I can get at it, and the Union Switch and Signal Co. arranged for its use. I may not be right. I do not want a libel summons, but that is what I have heard. This is hearsay evidence. They have adapted it to the electro-pneumatic cylinder, which Mr. Kinsman did not invent. And we decided to put it in our tubes under the Hudson River. That was one of the funniest things that ever happened on the P. R. R. There are very few people that know about it. There will be more after this.

The Committee of Three, not the Arbitration Committee or the Three Wise Men, but the Committee of Three on Signals of the New York Terminal, of which I was a member, decided that we would use the automatic stop in the tunnels. We decided that we would not put them outside because the interference with snow and ice might be very troublesome. The principle object was to prevent the angle cock on the train, which when hit opens the train line, from bging interfered with by lumps of coal and crossing planks and things of that kind lying along the road. So we decided to install it in the tubes only. The Committee made their recommendation to the Committee on Yards and Terminals. I think Mr. O'Donnel was a member of that committee. And they approved it. Then it was put up

to the big committee ,the Joint Committee on the Operation of the Yards and Stations and Structures. They approved it. With all that tremendous influence back of it, it is no wonder that the Vice-President and the President approved it. We euipped all our electric locomotives and all our multiple unit power and sent a trial train out on the Long Island. The first trip it struck a piece of crossing plank and got stopped, and then we made the discovery that even if we had only put the trips in the tunnels the trains that ran outside might hit things. We did not get at it by synthesis or analysis, but by hard knocks. Then Mr. Hill started to see if he could develop something, and he did, which device is shown in the Union Switch and Signal Co. bulletin No. 63.

It is a mighty ingenious proposition and is working with very satisfactory results on our trains today. So when some people tell us there is no satisfactory automatic stop we have to say that if you want that kind of thing we have just the kind of thing you want. I don't believe we want it for a good many years. It will tie up your railroad where you have mixed traffic. The conditions on the Interborough and in our tubes today are ideal for an arrangement of that kind. Trains are run at approximately the same speed and the same spacing in the rush hours, and the same class of trains and equipment, high-class passenger trains, no slow drags or shifting movements, and the simple fact that it works out there is no proof that it will work out on the steam line.

[NOTE.—In connection with the subject of automatic stops I would like to call your attention to an Analysis of Causes of All Noted Steam Railroad Accidents from July 1st, 1908, to January 31st, 1913, based on reports of the Interstate Commerce Commission, by Mr. P. J. Simmen, of the Northley-Simmen Signal Company, given on page 114 of the April,, 1913, issue of "The Signal Engineer," and my reply thereto on page 164 of the May, 1913, issue of the same publication, which might be of interest to the members of this Club.]

I honestly believe that after we have got our roads signalled with what money we have left after we have paid the income tax and the other taxes and the excessive amounts which we are compelled to pay by legislation; after we have got rid of all

the grade crossings in New Jersey at our own expense and done a few other little things that need fixing, and have tried out discipline and our safety committees have done their work and after the enginemen have become awakened to the honor of their profession, and the fact that good men are being imperilled when the careless and slovenly men are protected and backed up, after the men get so that they feel that they should weed out the poor men—and there are a few—with the improved discipline, improved feeling, *99* out of 100 of the accidents and collisions which might be prevented by automatic stops would be elminated and we would not have the dangers which the automatic stop imposes of taking control of the engine out of the engineer's hands. I do not believe that any engineman running wants the control of his machine taken from him at a critical moment. I do not think it is necessary. After we have done all of those things if our safety first movement will not take care of the balance then I think the time will come to try, not automatic stops which apply the emergency, but a speed control that will take care of the speed as soon as it reaches a given limit. I don't think we want the emergency stop. I don't think we want to take the control of the engine from the engineman if he is attending to business. I think we should have some device that will control it for him and register it. Men are working on it and it will not be invented by a man that does not understand the business.

It is a crime the way the U. S. Patent Office is issuing patents to poor devils that can't afford to pay for them, that are not worth the paper they are written on. I had a patent offered to me five years ago, invented by a Baptist minister in Tennessee ,assisted by a grocer, bearing the indorsement of the U. S. Government, for an improvement in the art of controlling trains. It consisted of a trigger stuck out alongside the track, which hit an angle cock on the engine, but it did not open the train line. Instead it opened the outlet of a cylinder on each side of the engine containing ten gallons each of black oil, the cylinders being located just in front of the drivers. As the oil was poured on the rails the drivers slipped round so that the train could not proceed any farther. That is true. Those fellows sent that to me and I could have bought it for only $10,-000; but our people would not do it! You can see how the

poor inventer is oppressed. They finally got a committee and it cost this country $50,000 to investigate just that kind of stuff.

A fellow came into our office the other day and Mr. Anthony listened to him for two hours, and the fellow was in earnest. I never saw a more earnest man, even at a revival meeting. It was an open circuit, of course, but wires will not break in such cases, we are told. When the train struck the point of the trip it closed the circuit, if Providence was kind, and it put the current through a flashlight powder, which exploded, making a flash of light. In order that the engineman might not think it a flash of lightning he had it liberate smoke, which filled the cab, and then the engineman knew he ought to stop or choke to death. If he still disregarded the fire and smoke and proceeded to go ahead into the mouth of hell, he had two cartridges with bullets in them and these cartridges exploded and the bullets were aimed to go into the train line without injuring the engineer or fireman.

Those are just samples of what we get every day. Then you will see articles in the daily press about how the railroads through meanness and parsimony will not adopt immediately the first automatic stop that is handed out. It is a hard situation. Maybe some paper will print some of this and perhaps change the course of public opinion. The Manufacturers' Association are doing a great deal in that line. I can not help but feel that a great Club of this kind can do a great deal in disabusing the minds of the public of the idea that if they get an automatic stop the millenium has come. I am much obliged to you for listening to me so long.

PRESIDENT MITCHELL: Gentlement, the subject is now open for general discussion and we hope that it will be widely participated in. If there are questions to ask Mr. Rudd will be glad to answer them. I will first call on Mr. I. S. Raymer, Assistant Signal Engineer, P. & L. E. R. R.

MR. I. S. RAYMER: When I was invited to attend this meeting tonight and listen to my friend Mr. Rudd, I accepted at once. I am glad to have heard Mr. Rudd speak. He is a very ordinary looking man, but if this Club exists a couple of hundred years and looks back on the history of signaling, you will find Mr. Rudd's name on one of the peaks of signaling his-

tory. The scheme you see there looks somewhat simple on paper, but if any of you gentlemen were members of the Railway Signaling Association during the time this scheme of indications and aspects was threshed out you will know that Mr. Rudd is one of the men away in advance of the most of us. You will know also that he had to fight hard to get some of us conservative men to follow him. I believe he has a good successful scheme, and as he says it is adopted now and will be adopted by a number of the railroads to their advantage.

I do not know so much about the automatic stop. We have not had any experience on our road. But I have heard quite a good deal about it. I believe with him though that railroads should go very cautiously in accepting any stop that we have on the market today.

PRESIDENT MITCHELL: We have with us tonight Mr. R. L. O'Donnel, General Superintendent, Pennsylvania Railroad. We will be glad to hear from him on this subject.

MR. R. L. O'DONNEL:—Mr. President and Gentlemen: I came here tonight to listen to the address of my old friend, Mr. Rudd, and have enjoyed the meeting very much.

I was astonished when the Secretary of the Club stated there were 1062 members. As the Club considers technical subjects, wholly, and has its meetings after the usual hours of labor, it speaks well for those who attend the meetings.

It occurred to me while Mr. Rudd was speaking that his scheme, as outlined, is a finished product, but the enginemen using the signals must recognize that we are passing through a transition period of signal construction. Many times the upper and lower quadrant signals will be found within a few miles of each other, and this calls for close attention on the part of the engineer. Referring to the figures given by Mr. Rudd (millions of dollars being spent yearly) it will be readily understood that it is impossible for the railroads to come to the finished product immediately, so that enginemen who are interested must bear with the railroads in trying to reach that finished ideal of Mr. Rudd, though the work is going on constantly.

Mr. Rudd took occasion to take a "fall out" of Mr. O'Donnel, and I cannot help referring briefly to the Manhattan Terminal Operating Committee which considered the plans of tracks,

crossovers and signals. During a discussion one day on the question of signals at this terminal, Mr. Rudd found that all of the tracks were wrong which the Superintendents and Engineers had planned for the movement of trains, in that they did not conform to his idea respecting the placing of the signals. Mr. Rudd was working under the assumption that the tracks should be built for the operation of signals rather than for the movement of trains. After he had found fault with the manner in which the tracks were laid out, and had shown how it was impossible for him to signal these tracks, some one asked him whether he really wanted to operate the trains or build signals. After considering the matter for a short time he said, "Well, I think we will be able to build the signals after the tracks are completed," and he has built what he claims, and what I believe every one will acknowledge, is one of the most magnificent systems of signals in the United States.

I thank you.

PRESIDENT MITCHELL: Here is a man I know will talk—Mr. J. T. Cole, engineman of the P. R. R.

MR. J. T. COLE: This is my first trip to Pittsburgh to attend a meeting of this Club. I have only been a member a very short time. I must say I have enjoyed and appreciated the meeting very much. Mr. McLaren, Asisstant Road Foreman of Engines, came to our town a few years ago and gave us a lecture on signals. Our Y. M. C. A. Secretary asked me to bring in a little something after he closed, and on that occasion I wrote a little number entitled "The Dutchman's First Lesson in Signals," which with your permission I will recite.

SIGNALS.

Ven I comes here to fire,
  Vos boudt dree years ago,
I found me oudt so many dings
  Vot a feller had to know.
Dot feller vot examined me
  Had some down on his upper lip;
He tole me boudt dem signals,
  Yust vos givin' me a quiet tip.

He had hanks of yarn, boudt ten bounds,
  He said vos green and red,
Dinken dot I vos fool enough
  To believe yust all he said.
I pick me oudt ten shades of each,
  And drows dem over von stick;
Purty soon he vonts me listen
  To a vatch vot didn't tick.

He held her aboudt ten feet away,
  And I said I could hear her go;
And den a lot of odder dings
  Dot feller yust vonted to know.
If I could vork some decimal fraction,
  And read mit only von eye;
He said you be good railroad man
  I should never *tell von lie.*

He send me to Mr. O'Brien,
  And he treat me mighty good;
He send me oudt dot very night
  To learn yust vot I could.
He tell me boud dem rules
  And boud dem signals, too;
I dot de vay he talked to me
  Vos only yust talkin' to do.

Dot engineer talk signal, too,
  Boudt semaphore and pot,
But dit not take me long to learn
  Dot voudn't keep her hot.
Dot fireman he talk signal ,too,
  Boudt go ahead and back,
And ven you want to stop von train
  Yust swing across dem tracks.

Dere vos so many lanterns
  Hanged on some poles so tall;
And ven it vos a vite von
  Dot brakeman yelled *"High Ball."*

And ven he call a green von,
  Yust so kind und modest like,
Dot engineer by von look, says,
  "It vos time you take a hike."

And next I see von signal
  Yust like von big red ring,
Dot engineer seemed kinder scared,
  But he didn't say any ding.
He seemed so mighty busy
  He had no time to talk;
I looked me around and dot blamed fireman
  Vos a-getting off to walk.

I see me den tree red vons,
  Yust a-getting so mighty close,
I try to get off and valk some, too,
  And you bet I skinned my nose.
Dot engineer laughed
  And he said, "Oh, I see;
You vos tryin' to swing
  Some more red on me."

Vell, I learn dem signals every one,
  I learns 'em in a hurry;
And der vos another von,
  I learn it here in Derry.
Vos stayin' mid my girl von night—
  It vos only half-past two—
I hear some rappings on der floor,
  I not know vot to do.

I axed my girl just vot it mean,
  And she said you ought to know,
Ven der old man's rapin' on der floor
  Vos a signal for you to go.
But of all dem blace I ever seen,
  For signals or for signs,
Dey beats de vorld, dot's vot dey do,
  Dem Pennsylvania Lines.

PRESIDENT MITCHELL: Mr. J. Z. Dickson, Signal Foreman, P. R. R.

MR. J. Z. DICKSON: I came here tonight as a visitor. I was very anxious to meet Mr. Rudd. I have had a very broad experience in signal business and I am very glad to be here. I have profited very much by the remarks that I have heard from Mr. Rudd.

PRESIDENT: Mr. A. B. Pollock, Supervisor of Signals, P. R. R.

MR. A. B. POLLOCK: One question I would like to ask in connection with the aspect showing a distant signal to an interlocked home signal outside automatic signal territory. This signal, in addition to performing the function of a distant signal, would also be a distant switch signal for a switch located between the home and distant signal. Would it not be better practice to have a separate signal to indicate the position of the switch?

MR. RUDD: The theory is that the switch light is the home signal; that the distant signal to be used for the home signal is the one that tells nothing about the occupancy of the track. It does not make much difference to a man whether the signal indicates stop at a switch light or a semaphore. He has the information that he has got to stop and his job is to come under control prepared to stop at the red light wherever it is.

I presume Mr. Pollock refers to the condition where we have a distant signal 3,000 or 4,000 feet from the home and perhaps 2,000 feet in which we have a switch. In that case the man must be prepared to stop at that switch, and if he finds it all right he must still be prepared to stop at the home. Of course, that loses time. It may have some element of danger if that engineman 999 times out of 1,000 finds the switch right and the home against him and gradually relaxes his vigilance and runs faster than he should after receiving the caution signal, and so gets into the open switch. I would say that in a case of that kind it might be properly covered by an automatic signal. It is our troubles that lead us to improvement more than the misfortunes we escape, and the difference between a man and a jackass is that a jackass never changes his mind. So perhaps we may decide that our present practice is wrong and that we

may need an automatic signal at that point, so arranged that if there were anything on the track or the switch open the signal would show stop, and if the track were clear and the next signal at stop it would show caution. We tried that in one case where we had two or three switches strung out one or two thousand feet apart. Of course, a train might come up against a red signal without any distant, but a fast train under absolute block would never do this except for signal failure or switch open, and in the latter case it probably would not get by very far, while under normal conditions it would receive caution and clear. I originally advocated another aspect for a distant switch signal something like a canoe paddle with a hole in the middle. Our people did not take kindly to it ,and when I got out over the country and found the objection to a multiplicity of aspects we pulled in our horns on it. I have had the system criticised because there were too many aspects. I analyzed the number of signal aspects on a leading railroad in this country a short time ago and found that there were 165 that enginemen had to remember. You can see how many there are here. Another one probably would not hurt very much.

PRESIDENT MITCHELL: Would any gentleman like to say a word or ask any questions? Opportunity is now given.

MR. GUY P. THURBER: I cannot let the opportunity go by without thanking Mr. Rudd for the chance to see what an engineer has to learn. I am not a locomotive engineer. Probably most of you will recognize me as having delivered a lecture once before you. But if I were an engineer and were put up against a line of signals like that and had to learn them, I am afraid I would make a mistake some time and go by. I was at one of our safety rallies here a few weeks ago. About 6,000 members could not get into the original hall. And the main thing that seemed to be in the minds of all the speakers was the danger of the human element. They were trying to educate the poor engineer and fireman not to stay up too late and not to go into the saloon and all these things. Now, what is going to take care of that sort of thing? I judge from the remarks of Mr. Rudd that he evidently has not been on a train that has been stopped automatically. If he had he would not have said there would be danger in stopping the train. I have been on trains going at 60, 70 and 75 miles an hour that were stopped

automatically, and on freights running 30, 35 and 40 miles, and the conductor talking with me said, "That is the finest stop I ever saw in my life. No engineer could make a stop like it." Government engineers were sitting in the train and one of them turned to the engineer and said, "How did it go?" The engineer said, "I could not beat it." That is an automatic stop.

I would like very much if Mr. Rudd and all the signal engineers here would listen to a paper I will deliver before the Pittsburgh Branch of the American Institute of Electrical Engineers on the 10th of June. It will be a technical paper on exactly what has been accomplished by automatic control of trains, illustrated with 100 slides, which Mr. G. B. Gray's brains, an associate of Mr. Rudd, has been the means of bringing out. I think when engineers know what train control is, how it works and how simple it is, they will be glad to give it at least one of Mr. Rudd's trials before all the money appropriated by his company is spent.

MR. RUDD: I would like to correct Mr. Thurber in his quotation of some of my remarks. I did not say anything about it being dangerous to stop a train running 75 or 80 miles. I have been on trains with automatic stop. I have examined several. Have ridden on the engine. I know what they will do. I said a slow drag freight running nine or ten miles an hour would stop with unpleasant consequences, or words to that effect, when the emergency application was applied. Mr. Thurber is, of course, interested in the automatic train stop and speaks possibly a little selfishly. I spoke in the most altruistic frame of mind. Speaking selfishly as a signal engineer and with disregard for all the other branches of the service, an automatic train stop would be a mighty good thing for me personally. I figure it out this way. We eliminate the human equation of the engineer that we hear so much about.

Now when you take the control of the engine out of the engineman's hands you remove a great amount of his responsibility. But in removing the human responsibility, the human equation, from the engineer, you place it on the signal maintainer, who has to take care of that stop and keep it in perfect order, along with a good many other things. As we all know the salary increases as the responsibility increases, not necessarily the knowledge, but the responsibility, and the result in all

equity would be that the signal maintainer would receive the salary now received by the locomotive engineer, and he would receive the salary now received by the maintainer of signals. In that case the supervisor of signals would have to get more money and the inspectors more, and then out of pure shame the management would raise my salary.

MR. R. M. LONG: I want to say for electric signals, either automatic or thrown by hand, that when decent lights are placed on them they are right for eight or ten miles per hour trains. But running through a district where they have a fog and at high speed they will confuse you. An engine does not ride any too good at best, and while you are going through fog at 60 or 70 miles an hour with signals 1000 feet apart you must know every jolt of that engine to catch that signal, and then you merely get a glimpse of it. "Fishtails" and all the rest of them are all right in the day time and with a good light, but at night or in a fog they are hard to see and a man ridng ahead of four or five hundred people at that speed must be sober and he must have over three hours' sleep to catch them. I believe that automatic signals should be placed as close as possible to the right hand side or the side on which the engineer sits who is handling the train, and be sure to place those signals so that at night they are not directed at an angle or in such a manner that one could get confused in them and not too close together. As I said, it takes a man with a quick eye to catch signals at high speed in the fog or smoke dropping down from a third track. I saw a train turned over not five miles out of Pittsburgh caused by an engineer who thought he had the right of way but the smoke from a freight train on the track along side of him dropped and he missed it, and it was at nine o'clock in the morning, too. Then too the question of height of signals. I would suggest that they take their gauges of height from a locomotive cab window, where one does not have to look straight up or far over to the side to get proper line of light from the signal. The placing of signals is about half the battle with those who ride ahead of the train. And I must say for our road (the P. & L. E. R. R.) that any complaint, no matter how large or how small, is taken up and remedied. Therefore, I think we have about as nice an automatic signal line as I have ever ridden over.

MR. J. K. SHERMAN: I would ask as to the source of electric power for the signals where alternating current is used.

MR. RUDD: The Pennsylvania is equipped on the main line where we are new installing the A. C. signals with track tanks 20 to 30 miles apart, requiring pumping stations and steam heating plants for use during the winter, at these points generators produce current at 3300 volts. We run an underground power line, No. 4 or No. 6 insulated wires laid in trunking about 20 inches below the bottom of the rail and the wires pitched in. The current is transmitted from the power plant through this line to transformers at each signal location and transformed to 110 volts for the motor and to 12 volts for the electric light and to track transformers with voltage varying from 5 to 15. At each signal location in addition to the transformers there are oil switches so that if we get a short circuit or a broken line between any two signals we can by these oil switches cut out the defective points and by starting the generator at the opposite end of the section keep all our signals going except possibly one or two. The current is fed ordinarily in only one direction. But at each power plant there is a duplicate generator so that if we have trouble at one end of the line we can start up the generators at the other end of the line and keep a fairly continuous service. Of course if we get our power line in bad trouble in two or three places the signals in between are cut out, with the motor signal and primary battery at each signal, if there is trouble only one signal goes. With a storage battery the same is true. With our old electro-pneumatics we had a storm and the charging line (500 volts) for the storage battery, went down and was down for a week and we kept the signals running from the storage. I think probably there is less chance of a general interruption from the D. C. with primary battery at each signal location than there is with the A. C. with the source of power 15 or 20 miles away. But the A. C. we believe must be used to guard against the dangers of false clear failures due to foreign currents, so that we are installing it as fast as possible and as we have money available. And if you have your track circuit A. C. you might just as well make your signal motors A. C.

We also get a good deal better light with the electric light than we do with kerosene. It is steady, and more reliable.

Do not think for a moment that we have not been working on the light proposition. I have made a test in the last two or three weeks of some new lenses, inverted lenses which do not weaken the direct ray down the track but increases the divergence 30%, so that if the light is set at the center of the curve you get principal focus at the center of the curve and you get also light approaching the center and receding from it, so you get a much wider illumination than with the present lens. And we have been experimenting with some green roundels that have a 30% more penetrative effect than the present ones. The light question is not a dead one yet by any means. Light is of course the essence of the signal at night and there can not be too much study devoted to its improvement.

PRESIDENT MITCHELL: The time has come to close the discussion. Mr. Rudd, do you wish to say anything further.

MR. H. B. PIERCE: During the greater portion of my railroad experience my opportunity for acquiring an education on automatic signals was limited largely to the experience of Mr. Cole's Dutchman. Jump or you will be killed. I have also had some experience along the same lines as he did with his girl's father. That was permissive. You may go. Then on other occasions they are automatically applied. You must go. I came down here with the intention of being instructed. Thanks to the intelligent manner in which Mr. Rudd has handled this talk, I have not been disappointed. He has suggested, I will admit wisely, too, a signal other than white and green to indicate proceed or caution. For the same practical reason why would he not suggest a signal other than red to be set on the post staggered with the signal lights?

MR. RUDD: You mean some light other than a red fixed light?

MR. PIERCE: Yes.

MR. RUDD: Because if the active light fails on that signal it should still be a stop signal. Take this signal, two red lights. Suppose one light is out, you still have a stop signal. Suppose you make the fixed light green, and you put the other light out. It is not a stop signal any more. Suppose you make it white. It is not a stop signal any more. The idea is that when you put the active light out, the light that gives permission to proceed, you still have a stop signal.

PRESIDENT MITCHELL: Does that answer your question?

MR. PIERCE: Not exactly. It gives an engineer permission to pass a red signal where he has a white signal at the same time.

MR. RUDD: Suppose you put both lights out at once. You have no signal. Suppose you put a green light there. That lets you go ahead. A white light tells you to go ahead. You are in a bad fix, You are in the same fix as Mr. Kopp was when we wanted to get an additional color. He said "the trouble with us is that our eye sight is limited and the Lord did not give us a long enough spectrum."

MR. D. M. HOWE: After listening to the very intelligent and able address by Mr. Rudd and the remarks by the many gentlemen here tonight, I have noticed particularly some words spoken by Mr. Rudd. One point in referring to the kindness of the Pennsylvania Railroad in appropriating $5,000,000 for the signal department. He said you would wonder where it comes from—but did not tell us where it went to. Mr. Rudd also injected a great deal of humor into his remarks. And there is one thing I admire about his jokes. We laughed at them, but he did not. Most jokers when they tell a joke do all the laughing.

However, as I know nothing more about signals than what I have already said, I move you, Mr. President, that we give Mr. Rudd a rising vote of thanks for his very able address this evening.

The motion was carried by unanimous vote.

MR. RUDD: Gentlemen, I am very obliged to you. I might say that the reason I did not laugh at those jokes is because I have heard them before.

PRESIDENT MITCHELL. Gentlemen, this is the last meeting until September. We hope that in the fall you will all remember that there is such a thing as The Railway Club of Pittsburgh and that you will be present.

ON MOTION. Adjourned at 10:18.

J.B. Anderson
Secretary.

In Memoriam

GEORGE H. SMITH

MECH'L ENGINEER, CARNEGIE STEEL CO.

DIED MAY 20TH 1913

In Memoriam

JOHN T. BROWN

VICE PRESIDENT AND GENERAL MANAGER

DAMASCUS BRONZE CO.

DIED MAY 20TH 1913.

OFFICIAL PROCEEDINGS
RAILWAY CLUB OF PITTSBURGH
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OUTING AT WILMERDING, PA.,
AS GUESTS OF
THE WESTINGHOUSE AIR BRAKE COMPANY.

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OF

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Past Presidents

J. H. McCONNELL	October, 1901, to October, 1903.
L. H. TURNER	November, 1903, to October, 1905.
F. H. STARK	November, 1905, to October, 1907.
* H. W. WATTS	November, 1907, to April, 1908.
D. J. REDDING	November, 1908, to October, 1910.
F. R. McFEATTERS	November, 1910, to October, 1912.

* Deceased.

Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, SEPTEMBER 26th, 1913.

The members of the Club, their ladies and friends, about 450 in number were the guests of The Westinghouse Air Brake Company at Wilmerding for a day of outing and entertainment. A registry of the following members and visitors was taken on the train enroute:

MEMBERS.

Alexander, J. R.
Allison, John
Amsbary, D. H.
Anderson, J. B.
Ashley, F. B.
Baker, J. H.
Barker, A. E.
Bauer, A. C.
Bennett, R. G.
Berghane, A. L.
Brandt, E. K.
Brooks, W. A.
Boyle, Harry E.
Buckbee, W. A.
Buechner, W. A.
Bugle, Geo.
Burke, William
Burns, R. C.
Byron, A. W.
Carpenter, H. L. Jr.
Cassiday, C. R.
Christy, F. X.
Clark, C. C.
Clifford, W. J.
Code, J. G.
Cole, J. T.
Cooper, F. E.
Cooper, J. H.
Cotton, A. C.
Courson, J. F.
Courtney, D. C.
Crenner, Jos. A.
Croft, E. P.
Cunningham, R. I.
Dambach, C. O.
Detwiler, U. G.
Dobson, O. C.
Drake, Thos. E.
Drake, W. C.
Drayer, U. S.
Dunlevy, J. H.
Elverson, H. W.
Falkenstein, W. H.
Fitzgerald, D. W.
Flaherty, P. J.
Forsythe, Geo. B.
Ferguson, D. E.
Fray, Saml.
Frazier, E. L. Jr.
Freshwater, F. H.
Funk, Sterling R.
Gale, C. H.
Gallinger, Geo. A.
Gies, Geo. E.
Goetz, H. L.
Grewe, H. F.
Grove, E. M.
Hardman, H. J.
Harner, A. J.
Haselett, D. H.
Hastings, C. L.
Haynes, J. E.
Hilty, H. A.
Hoffman, C. T.
Howe, D. M.
Howe, Harry
Hood, S. F.
Hudson, W. L.
Hurley, Theo.
Jefferson, E. Z.
Kelly, H. B.
Kinch, L. E.
King, W. R.
Kleine, R. L.

Knight, E. A.
Knickerbocker, A. C.
Koch, Felix
Kopfershmidt, B.
Lakin, J. H.
Lambe, G. C.
Latimer, W. B.
Laughlin, E. J.
Lehr, H. W.
Lewis, A. J.
Lindstrom, C. A.
Low, J. R.
MacQuown, H. C.
Mason, E. F.
Mensch, E. M.
Millar, C. W.
Millar, R. J.
Mitchell, A. G.
Mitchell, A. F.
Morrison, R. J.
Mullin, D. C.
Murphy, W. J.
McCann, J. P.
McCauley, Wm.
McCully, John
McGaughey, Chas.
McIntyre, G. L.
McKee, S. Frank
McNaight, A. H.
McNulty, F. M.
Neal, John T.
Newman, J. F.
O'Connor, M.
Orner, M. T. S.
Parks, F. H.
Peach, W. M.
Pearson, A.
Perry, W. E.
Peters, W. P.
Proven, John
Phillips, Lee
Pfister, A. J.
Pollock, A. B.
Porter, Chas.
Postlethwaite, C. I.
Rabold, W. E.
Ream, A. H.
Redding, D. J.
Reed, David K.
Rice, D. S.
Richardson, W. P.
Rivinius, Carl
Robbins, F. S.
Runser, K. W.
Ryman, Frank
Sattley, E. C.
Scheck, H. G.
Schuchman, W. R.
Schreiner, W. C.
Schultz, Geo. H.
Shook, H. J.
Shook, S. D.
Shults, I. Jay
Smoot, W. D.
Snyder, J. Rush
Stark, F. H.
Stevenson, R. F.
Stoddart, W. G.
Stucki, A.
Stumpf, F. L.
Sullivan, W. H.
Swartz, H. E.
Swope, B. M.
Taylor, F. C.
Truax, W. E.
Voight, A. J.
Walter, W. A.
Walther, G. C.
Ward, F. B.
Walker, J. W.
Warfel, J. A.
White, F. L.
Wittig, Wm.
Wood, Ralph C.
Wright, R. V.

VISITORS.

Allen, E. K.
Beals, G. W.
Brunner, F. J.
Bird, F. J.
Burrell, J. F.
Bannen, W. J.

Burson, H. A.	Minor, L. L.
Berry, Oliver	Morris, D. R.
Beebe, Ira L.	Morris, H. W.
Cross, C. W.	McNulty, R. M.
Code, G. H.	McNeill, J. J.
Code, C. J.	Niebaum, W. H.
Callahan, John	Norris, W. B.
Conner, E. C.	Newburn, T. W.
Douglass, E. A.	Osbourne, A. S.
Dudley, G. W.	Ransbury, F. S.
Edwards, G. H.	Rhoads, G. E.
Finley, Jas. A.	Russell, Jas. R.
Fleming, H. W.	Ryman, G. L.
Gawthrop, W. J.	Siegrist, J. S.
Gallagher, F. S.	Schuchman, B. F.
Glass, J. C.	Smith, William
Glass, J. C. Jr.	Smythe, W. C.
Jefferson, H. F.	Sneck, Harry
Keyser, R. H.	Stewart, G. M.
Kelley, W. H.	Spreen, F. A.
Kendig, W. M.	Sullivan, P. K.
Laylin, M. H.	Ulmer, E. F.
Latschuh, J. H.	White, W. A.
Mayhugh, J. R.	Wyman, G. S. Jr.

Yohe, J. K.

In addition to the above a large number of the members and their ladies met the party on arrival at Wilmerding. There were about 160 ladies in the entire party.

The party left the Pennsylvania Station, Pittsburgh at 3 p. m. on a special train composed of modern suburban steel coaches and upon arrival at Wilmerding they were met and welcomed by Mr. A. L. Humphrey, Vice President and General Manager and his staff Officers. While being conducted through the entrance to the Works the party was greeted by music rendered by the Star of Liberty Band of Wilmerding composed of employes of the Westinghouse Air Brake Company after which a group photograph was taken and is reproduced in these proceedings. When the party was being assembled and dispatched in groups of twenty-five in charge of competent guides for the trip through the Works a moving picture was taken which was reproduced later in the evening on a screen in the Auditorium. This was a novelty and very interesting and from the expressions and poses of some of the party it is evident that they would make good subjects for the "movies."

Some of the ladies who did not care to take the trip through the Works were escorted to the Young Women's Christian Association in the Welfare building where they were presented with an American Beauty rose and entertained by the ladies of the officers of the Westinghouse Air Brake Company.

The trip through the Works was especially interesting because of the fact that the officers and guides in charge of the several groups explained everything of interest that time would permit and furthermore each guest was furnished with a program explaining in brief the different departments visited as follows:

PROGRAM.

ROUTE OF TRIP THROUGH SHOP.

(1) **IRON FOUNDRY NO. 1.**

Pass continuous moulding tables which make a complete revolution and return of sand every twenty minutes. Castings made in this Foundry from 2 oz. to 250 lbs. Total melting capacity per day 500 tons.

(2) **BRASS FOUNDRY.**

Capacity 40 tons per day. Nine furnaces each with melting capacity of 650 to 1000 pounds in 45 minutes.

(3) **BOILER ROOM.**

Equipped with 22 125-H. P. Boilers. Total H. P. 2750. Roney Stokers and continuous conveyor.

(4) **POWER PLANT.**

Five 400-Kilowatt and one 2000-Kilowatt Turbo-generator Units. All line shafting and power appliances in shops are motor driven. Switchboard (separated department) using oil switches.

(5) **MOTOR DRIVEN COMPRESSOR TEST ROOM.**

Devoted exclusively to experimental and research work.

(6) **DEPT. E—STEAM DRIVEN COMPRESSOR ASSEMBLY ROOM.**

Capacity 300 Cross Compound and 700 other sizes of compressors per month.

(7) ANNEALING, OIL TEMPERING AND HEAT TREATING PLANT.

Fifteen furnaces each 7½'x7½'.

(8) BLACKSMITH SHOP.

61000 sq. ft. 7-drop hammers of 600 to 2000 lbs. capacity. 4 trimming presses; 2 forging machines; 3 Bradley hammers, etc. Hose Clamp capacity 12000 per day.

(8-A) RESERVOIR DEPT.

Reservoirs of all sizes from 6" to 60" diameter and 20-ft. long. Equipped for making riveted, welded, brazed or acetylene welded reservoirs. Capacity 6000 reservoirs per month.

(8-B) RESERVOIR ENAMELING PLANT.

Reservoirs after completion are treated to a sulphuric acid bath in which all dirt, scale and iron oxide is removed. They are then treated in a lime-water solution for the purpose of neutralizing the acid remaining on the work, after which the reservoir is washed in pure water to remove lime-water. The reservoir is then thoroughly dried, after which it is heated and dipped its entire length in warm enamel, then baked in a specially arranged oven to dry the enamel. Special care is taken to insure proper temperature and time in baking. After the first coat is hard, the reservoir is given a second coat.

(9) CARPENTER SHOP AND BOX FACTORY.

(10) NEW FOUNDRY.

(Under construction).

(11) PATTERN SHOP AND PATTERN STORAGE.

About 30,000 complete patterns for use in air brake work are stored on specially constructed racks.

(12) IRON FOUNDRY NO. 2.

Air compressors and all special castings are made in this foundry.

(13) EXHIBITION OF INTRICATE CORING required in the moulding of air brake appliances.

(14) DRINKING-WATER REFRIGERATING PLANT.

Continuous circulation of pure mineral water from an artesian well to all parts of shop. Sanitary drinking fountains

in use exclusively. Water is analyzed periodically to insure against impurities.

(15) DEPARTMENT A.

Machining department for heavy castings, such as steam driven compressor cylinders, brake cylinders, auxiliary reservoirs, etc. The northern half of this floor is devoted to machining and assembling of all brake cylinders, with a capacity of 1000 brake cylinders per day.

(16) DEPARTMENT SS.

All motor driven compressors are machined, assembled and tested in this department to a given per cent of efficiency before shipment. Capacity 250 compressors per month.

(17) DEPARTMENT N.

(Friction Draft Gear Department).

Machining and assembling. Capacity 400 draft gears per day. All gears worn in and tested to a capacity of 180,000 lbs. before shipment. Springs ground in pairs to given length as well as physically tested.

(18) DEPARTMENT B.

Machining department for all small cast-iron castings. Semi-automatic machines for couplings with a total capacity of 7500 per day. Angle cock capacity 4000 per day.

(19) DEPARTMENT C.

Brass finishing department. Attention is called to four and six-spindle high speed drills for ports in slide walves; profiling machine; porting machines for slide valves with a capacity of 1400 per day; porting machines for bushings with a capacity of 1400 per day each having six or seven spindles; automatic cock key turning machines with capacity of 5500 per day; automatic rod machines.

(20) DEPARTMENT K.

Tool Room. Manufacture of shop tools and miscellaneous appliances.

(21) DEPARTMENT P.

Motor driven compressor accessories, experimental and other special work.

(22) DEPARTMENT D.

Machine fitting department for slide valve work. Test rack for freight triple valves, 60 cars. All freight triple valves pass a code of tests on this rack before passing to the individual test racks in Test Dept. Assembling and testing of all triple valves. Capacity 1000 per day. Locomotive equipment, 25 sets per day. Angle cocks, 4000 per day.

(23) ENGINEERING, TEST AND EXPERIMENTAL DEPARTMENT.

(24) DRAWING OFFICE AND CLERICAL OFFICES OF ENGINEERING DEPARTMENT.

(25) EXHIBITION FLOOR.

Test and demonstration racks of various forms of air brake equipment required by steam-road and electric-road service. Each rack is comprised of a number of complete car equipments including same amount of piping, etc., as installed on cars in service.

Freight equipment rack comprising complete air brake equipment for train of locomotive and 150 freight cars.

(26) CHEMICAL LABORATORY.

All Foundry products analyzed daily. Purchased materials made to specifications must be approved by this department before using.

(27) MEDICAL AND EMERGENCY AID DEPARTMENT.

Physician on duty at all times; services gratuitous and devoted exclusively to employees, in connection with Relief Department System.

(28) RELIEF DEPARTMENT OFFICES.

(29) WELFARE BUILDINGS.

Young Men's Christian Association and Young Women's Christian Association (separate buildings.) Combined membership 2500. Second largest membership in Pennsylvania. Completely equipped gymnasium, reading rooms, swimming pool, bowling alleys, shooting gallery, pool and billiard tables, etc., as well as class rooms for extensive educational work comprising all branches of study.

After completing the trip through the Works the ladies who made the trip were escorted to the Y. W. C. A. where they were each presented with an American Beauty rose and joined those who had preceded them. The men were likewise escorted to the Y. M. C. A. and allowed time to "brush up" and re-assemble with the ladies for an appetizing supper which was served in the Welfare building, third floor at 6 o'clock to the accompaniment of good music rendered by the Westinghouse orchestra.

At each plate a neat package was found containing a card calling attention to the display on the black-boards on the walls in the several rooms, illustrating the methods of instructing students. This package also contained a souvenir leather watch fob with the "trade mark" of the W. A. B. Co. attached.

The following menu was enjoyed by all:

PICKLES OLIVES

COLD TONGUE COLD ROAST BEEF

CHICKEN SALAD

TOMATOES LETTUCE

ICE CREAM CAKES

COFFEE CIGARS

Before and after the supper the use of the bowling alleys, swimming pool, shooting gallery, gymnasium, pool and billiard tables, games, etc., was extended to and taken advantage of by different members of the party.

After indulging in a social half hour following the supper, the party was ushered into the auditorium to the strains of an overture "Goddess of Night" by the Westinghouse orchestra. President A. G. Mitchell then asked the pardon and indulgence of the ladies and visitors for a few minutes until certain business matters were disposed of, this being the date of the regular meeting of the club. The following business was then transacted:

PRESIDENT MITCHELL: The roll call will be dispensed with as the Secretary has endeavored to obtain a list of the members present by registry cards. We will also dispense

with the reading of the minutes of the last meeting as they have been published and distributed to the members.

The Secretary read the following applications for membership:

Balsley, W. T., Inspector, Westinghouse Air Brake Co., 724 Middle Ave., Wilmerding, Pa. Recommended by A. A. Mackert.

Beebe, I. L., Rep. Dearborn Chemical Co., 1623 Farmers Bank Building, Pittsburgh, Pa. Recommended by D. H. Amsbary.

Billinger, G. C., Draftsman, Pressed Steel Car Co., 2538 Perrysville Ave., N. S., Pittsburgh, Pa. Recommended by Harry Howe.

Boenig, Geo. C., P. W. Inspector, P. R. R., Box 77. E. Liberty Sta., Pittsburgh, Pa. Recommended by C. T. Hoffman.

Brown, David S., Clerk, Penna. R. R., 814 South Soles St., McKeesport, Pa. Recommended by V. V. Wood.

Copeland, T. F., Road Foreman Engines, Carnegie Steel Co., Munhall, Pa. Recommended by R. I. Cunningham.

Cooper, Wm. M., Draftsman, Pressed Steel Car Co., 655 Maus Ave., Bellevue, Pa. Recommended by Harry Howe.

Crenner, Jos. A., Rep. Dearborn Chemical Co., 1622 Farmers Bank Building, Pittsburgh, Pa. Recommended by D. H. Amsbary.

Duggan, E. J., Clerk, Montour R. R., 1024 Oliver Building, Pittsburgh, Pa. Recommended by F. H. Stark.

Edwards, G. H., Dist. Supt. Pullman Co., Penna. Co. Building, Pittsburgh, Pa. Recommended by J. B. Anderson.

Felton, F. J., Supt. Car Wheel Foundry, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

Finley, Jas. A., Pittsburgh Air Brake Co., 818 Washington Blvd., E. E., Pittsburgh, Pa. Recommended by J. L. Tucker.

Germain, L. Jr., President Germain Lumber Co., Farmers Bank Building, Pittsburgh, Pa. Recommended by Chas. A. Lindstrom.

Grafton, John J., Asst. Machine Shop Foreman, Penna. Lines West, 1400 14th St., Wellsville, O. Recommended by D. W. Fitzgerald.

Gross, C. H., Draftsman, Pressed Steel Car Co., 1018 Stanford Road, N. S., Pittsburgh, Pa. Recommended by Harry Howe.

Holland, C. J., Foreman Casting Yard, Pressed Steel Car Co., 709 Fruit Way, McKees Rocks, Pa. Recommended by Harry Howe.

Holmes, C. W., Piece Work Inspector, Penna. R. R., Pitcairn, Pa. Recommended by C. T. Hoffman.

Huff, Geo. F. Jr., Motive Power Inspector, Penna. R. R., 345 N. Dennison Ave., East Liberty, Pa. Recommended by C. T. Hoffman.

Hunt, Harry L., Engineman, Winfield R. R., West Winfield, Pa. Recommended by U. G. Detwiler.

James, John H., Asst. Foreman, Penna. R. R., Verona, Pa. Recommended by W. A. Walter.

James, Robert E., Inspector, Westinghouse Air Brake Co., 341 Welsh Ave., Wilmerding, Pa. Recommended by A. A. Mackert.

Lansberry, W. B., Former Train Dispatcher, Monon. R. R., 248 West 9th Ave., Homestead, Pa. Recommended by W. T. Karns.

Laylin, M. H., Air Brake Inspector and Road Foreman Engines, W. & L. E. R. R., 2414 So. Erie St., Massillon, Ohio. Recommended by J. H. Cooper.

Livingston, B. F., Extra Agent, Penna. R. R., 59 North 1st St., Duquesne, Pa. Recommended by V. V. Wood.

Martin, T. J., Engineman, Monon. Div. P. R. R., Brownsville, Pa. Recommended by H. G. Scheck.

Maylock, E. A., Supt. Shop Tests, Westinghouse Air Brake Co., Wilmerding, Pa. Recommended by A. A. Mackert.

Middlesworth, G. E., Passenger Brakeman, Penna. R. R., 816 Bellefonte St., Pittsburgh, Pa. Recommended by Philip S. Pyle.

McClelland, W. E., Clerk, Penna. R. R., 237 Welsh Ave., Pittsburgh, Pa. Recommended by V. V. Wood.

McCollum, Geo. C., Draftsman, Pressed Steel Car Co., Engineering Dept., McKees Rocks, Pa. Recommended by Harry Howe.

McCurdy, C. E., Estimator, Pressed Steel Car Co., 624 Highland Plan, Bellevue, Pa. Recommended by Harry Howe.

McFarland, H. L., Draftsman, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

Newburn, T. W., Asst. Resident Engineer, Westinghouse Air Brake Co., Pittsburgh, Pa. Recommended by E. A. Craig.

Pauline, Jos., Draftsman, Pressed Steel Car Co., Box 116, North Diamond Sta., Pittsburgh, Pa. Recommended by Harry Howe.

Pratt, I. D., Motive Power Inspector, Penna. R. R., 419 Agatha St., Pitcairn, Pa. Recommended by J. F. Courson.

Richardson, L., Motive Power Inspector, Penna. R. R., 203 Penna. Station, Pittsburgh, Pa. Recommended by J. B. Anderson.

Shaffer, Wm., Gang Foreman, Penna. R. R., 114 West 3rd St., Greensburg, Pa. Recommended by C. T. Hoffman.

Sheets, Harry E., Chief Clerk, Traffic Dept. Montour R. R., 1024 Oliver Building, Pittsburgh, Pa. Recommended by F. H. Stark.

Sleeman, Wm. C., Draftsman, Pressed Steel Car Co., 205 Sagamore St., Pittsburgh, Pa. Recommended by Harry Howe.

Snyder, John W., Supervisor Signals, Penna. R. R., 124 West Penn Ave., Aspinwall, Pa. Recommended by L. E. Kinch.

Stewart, E. E., Secretary, Simplex Air Brake & Manufacturing Co., 436 Wabash Building, Pittsburgh, Pa. Recommended by D. C. Courtney.

Thomas, J. H., Asst. General Foreman, Penna. R. R., Pitcairn, Pa. Recommended by J. B. Anderson.

Thornley, E. W., Storekeeper, B. & O. R. R., Glenwood, Pa. Recommended by J. H. Cooper.

Wardale, H. G., Draftsman, Pressed Steel Car Co., 2926 Zephyr Ave., Sheridan Station, Pittsburgh, Pa. Recommended by Harry Howe.

PRESIDENT: When the Executive Committee passes favorably upon these applications they will become members of the Club.

SECRETARY: Mr. President we have the following proposed amendment to the Constitution which is prepared in accordance with article VII of the Constitution and is signed by ten members of the Club.

"In view of the increase in membership in The Railway Club of Pittsburgh during the past few years it is felt at this time that some of the Committees elected by the members of the Club should be increased in number. Therefore, we the undersigned members of the Club offer the following amendments to the Constitution:

ART. 4, Officers—That the Finance Committee consist of five members instead of three. That the Membership Committee consist of seven members instead of five, and that a Committee to be known as an Entertainment Committee consisting of three members be added.

Add to ART. 5, SEC. 8, as follows: The Entertainment Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents and such other duties as may be proper for such a Committee."

PRESIDENT: In accordance with Art. VII of the Constitution these amendments will be held over until our next regular meeting for action at that time.

PRESIDENT: At the September meeting it is customary to appoint a Nominating Committee to submit a list of names for the different offices in the Club. In order to save time I took the liberty of appointing such a Committee on the way out to Wilmerding. This Committee is R. L. Kleine, Chairman; E. M. Grove and E. A. Craig. Is the Chairman of this Committee ready to report?

MR. R. L. KLEINE: Mr. President, the Committee's report is in the hands of the Secretary.

SECRETARY: Mr. President, I have the report of the Nominating Committee as follows: Your Nominating Committee selected to nominate officers for the Club for the ensuing year beginning November 1st, 1913, beg leave to submit the following:

President, A. G. Mitchell, Supt. Monongahela Division, Penna. R. R.

First Vice President, F. M. McNulty, Supt. Motive Power, Monon. Con. R. R.

Second Vice President, J. G. Code, General Manager, Wabash-Pittsburgh Terminal R. R.

Secretary, J. B. Anderson, Chief Clerk, Supt. Motive Power, Penna. R. R.

Treasurer, F. H. Stark, Supt. Montour R. R.

Executive Committee, L. H. Turner, Supt. Motive Power, P. & L. E. R. R.; D. J. Redding, Asst. Supt. Motive Power, P. & L. E. R. R.; F. R. McFeatters, Supt. Union R. R.

Finance Committee, D. C. Noble, President Pittsburgh Spring &Steel Co.; E. K. Conneely, Purchasing Agent, P. & L. E. R. R.; C. E. Postlethwaite, Manager Sales, Pressed Steel Car Co.; A. L. Humphrey, Vice President and General Manager, W. A. B. Co.; L. C. Bihler, Traffic Manager, Carnegie Steel Co.

Membership Committee, D. M. Howe, Manager, Jos. Dixon Crucible Co.; H. H. Maxfield, Master Mechanic, Penna. R. R.; Chas. A. Lindstrom, Asst. to President, Pressed Steel Car Co.; A. Stucki, Engineer; C. O. Dambach, Supt. Wabash-Pittsburgh R. R.; O. S. Pulliam, General Manager Pittsburgh Steel Foundry Co., F. J. Lanahan, President Fort Pitt Malleable Iron Co.

Entertainment Committee, Stephen C. Mason, Secretary, The McConway & Torley Co.; R. H. Blackall, Railway Supplies; D. H. Amsbary, Manager, Dearborn Chemical Co.

Signed by R. L. Kleine, Chairman; E. M. Grove and E. A. Craig.

MR. D. J. REDDING: Mr. President, I move you that the report of the Nominating Committee be received and the

nominations close. This motion was seconded and unanimously agreed to.

MR. D. M. HOWE: Mr. President, I notice in the Constitution Article III, Sec. 2 that persons may become honorary members of the Club by a unanimous vote of all members present at any of its regular meetings and shall be entitled to all privileges of membership and not be subject to the payment of dues or assessments. I have in mind a grand old man who has been a member of this Club since its organization in October 1901 and for eleven years held the responsible position of Treasurer but on account of ill health was compelled to retire from active duty. He has been a good member and is deserving of being made an honorary member of this Club. I refer to Mr. J. D. McIlwain and I move you that he be made an honorary member. This motion was duly seconded and unanimously agreed to.

PRESIDENT: There being no further business before the Club we will adjourn and refer to the Program of the evening. I have the pleasure of now introducing Mr. A. L. Humphrey, Vice President and General Manager of The Westinghouse Air Brake Company.

Ladies and Gentlemen:

On behalf of the Company I represent I want to express my appreciation of the honor you have conferred upon us by accepting our invitation to be with us this afternoon.

We are especially pleased that we have been honored with the presence of the ladies, not only on account of the grace and dignity they add to the occasion, but for the opportunity afforded them to familiarize themselves, by personal observation, with what is going on in the manufacturing world, instead of having to depend upon what is written by sensationalists or platform spellbinders, whose price per page of manuscript, or per diem as an orator, depends upon the amount of sensation they are capable of creating in describing the conditions prevailing in the workshops and industrial communities of our country.

In the way of introduction it might not be out of place for me to review briefly the results of the activities of the Company whose guests you are today, and briefly depict the development and progress of the town of Wilmerding—"The Home of the Air Brake."

This town, or borough as it is called, was founded in 1889 at the time the Air Brake Plant was started, and now has a population of between six and seven thousand people. At that time I am told the site now occupied by the beautiful little village was occupied by one small farmhouse surrounded principally by blackberry bushes and frog ponds. The Works were completed and operations started in 1890, twenty-three years ago. Since that time the Company has undertaken and carried on a welfare and social betterment work which has perhaps been somewhat unusual in the industrial world.

The Company has built and provided for the inhabitants of this community a total of three hundred and twenty-one substantial homes, many of which you no doubt had an opportunity of observing, from a distance at least, during your travel this afternoon. These homes are occupied principally by employees of the Company, but in a few cases by other citizens of the community.

In addition to the homes referred to, the Company provided the building in which we are now being entertained and dedicated same to the physical, intellectual and social welfare of the district, and as an agency for carrying on the work the Young Men's Christian Association was selected. Membership in the Association is open to all inhabitants of the Turtle Creek Valley and it is most gratifying to me to state that the opportunities offered have met with such unprecedented favor that it is now the second largest in the State of Pennsylvania, having a membership of 2200.

In addition to this building, we have provided what is known as the Air Brake Welfare Club, with a membership of some 450, intended for the same class of work among the foreign settlers from Southern Europe employed in our Shops. While this Institution was started as an experiment, it has now been in existence for nearly five years with marked success.

We have also provided a building, which no doubt many of you ladies had an opportunity of inspecting this evening, for the young ladies and women of the community, which is the home of the Young Women's Christian Association. Here the same character of work is carried on for women as is undertaken for men in this building, and especially for young girls deprived

of the good fortune of such home environments as would fit them for future useful Christian lives.

The streets of the town are all paved and provided with perfect sewerage, water and light systems. It has two Parks and an Athletic Concourse and Playground all provided by the Company, while the Borough, I think I can safely say, has been managed by as able and competent a Borough organization as ever existed in the State of Pennsylvania.

The Company, for the purpose of encouraging cleanliness and attractiveness throughout the Borough, offers annually prizes for the best kept lawns, gardens, etc. Many of the homes competing for these prizes would do credit to any community, and it is with regret that we felt your physical endurance would not permit your being escorted to see them. The next best thing we can offer you, with less effort on your part, is pictures of some of the Company homes, which we will later display upon the canvas.

In the organization of the Air Brake Company, which employs some 4,500 men, we have what is known as the Veteran Employees' Association. Only those who have been continuously in the employ of the Company for twenty-one years or over are eligible for membership in this Association. They have one annual meeting which takes the form of a banquet and is held in the gymnasium of this building. No one is permitted to be present at this meeting except the members of the Association and invited officers of the Company who, like myself, are not eligible for membership.

We have a Relief Department, which pays relief benefits in case of sickness or injury, and Pension all employees who reach the age of seventy years and have been in the continuous service of the Company for twenty years or over, or have become incapacitated.

The activities of the Company are confined exclusively to the manufacture of Railway specialties, and, as we are so closely associated in every respect with the railways of the country, it might not be out of place to relate some of our achievements.

In the Plant of this Company alone has been manufactured 2,800,000 sets of brakes for Freight Cars; 78,400 sets of Locomotive equipment; and 86,300 sets of Passenger equipment. If the railway rolling stock to which this apparatus was applied

was coupled in one solid train it would equal a distance of 23,000 miles, and would encircle the world on the parallel of Pittsburgh one and one-fifth times. If the freight cars were coupled in one continuous train and you should overtake them riding on a Passenger train, traveling 30 miles per hour, it would require twenty-nine days and nights to pass this freight train.

It would require to handle the raw and finished material entering into the manufacture of this equipment, to and from the Wilmerding Plant since it began operations, over 70,000 cars of freight, which, if coupled in one train, would extend from Pittsburgh to a point 100 miles West of Chicago. This Company holds the distinction of manufacturing and controlling one product used on passenger equipment the world over. In other words, it is possible for a person to start from New York and make a trip around the world and every passenger car on which he would travel would be equipped with apparatus of either our own manufacture or that of one of our subsidiary Companies in a foreign country.

This Company was the first to develop and perfect a safety appliance to be used on the Railways of the world. The Air Brake was first intended to control passenger trains only, and its usefulness had hardly been demonstrated until the American Railway Managers appreciated the full scope of its value, and, as has been the case many times since, undertook to equip the passenger cars of this country at an enormous expense to the railroads.

It was not long, however, until some of the mountainous roads, appreciating the added safety in the handling of passenger trains, thought it could be utilized with the same degree of success in the handling and operation of freight trains, and with this end in view the application of brakes to freight cars was undertaken by the Railways of the Country with the result that the use of same became universal.

Notwithstanding the success achieved in this country and the improved transportation facilities and methods made possible thereby, this is the only country, with the possible exception of two, in which this safety feature is used on freight cars. It is just such aggressiveness as this that has built up the wonderful Railway Systems of America, and has contributed so largely towards developing an empire in the western part of our country

covering an area greater than all of Europe, a country that had it not been for the Railways would have remained for many years in the condition in which I had the privilege of seeing it thirty odd years ago, when I was connected with the Union Pacific Railroad in the wilds of the Rocky Mountains, and which was the only transcontinental Railway across the continent at that time. In those days the guards carried upon a passenger train, in order to protect the train from the outlaws and bandits, and the passengers from the ravages of the three card monte men, nearly equalled the number of passengers carried.

At that time there was an average freight traffic over the road of about three trains per day each way, consisting of as many as fifteen cars per train, handled by two "monstrous" locomotives of those days, weighing as high as 90,000 to 100,000 pounds on drivers. It was this nucleus of freight traffic at that time that prompted the far-sighted Railway builders of the country to push developments until today there are nine or ten transcontinental lines across the continent.

Notwithstanding the many discouragements, receiverships and failures encountered by the different Railways constructed across the continent, we find people who still claim that, although our freight and passenger rates are scarcely one-half of what they are in foreign countries, the Railroads are robbing the people and giving nothing in return.

A great deal has been said and written the past few years regarding the Conservation of our Natural Resources and the necessity of a "Safety First" campaign. As stated in the first part of my remarks, little is said by journalists or orators about what has been accomplished, but a great deal of fuss is being made about what should be done in the railroad and manufacturing world along the line of safety.

I have related the advance step taken by the Railroads in the introduction of the Air Brake, which was followed by the introduction of many other appliances equally as important, and about the only credit the railroads received after this work had been largely accomplished was the passing of laws making the use of such safety appliances compulsory.

I know from my own observation and my long association with Railroads that the foremost thought in the minds of the officers at the head of the great systems contributing so much

towards the development of this country has been not only the conservation of our natural resources, but the conservation of the human race by the elimination of accidents. The development and introduction of appliances for the safety of the traveling public and the railway employees has kept far in advance of any conceived idea of the necessity for such devices by those that clamor the loudest for them after they discover they have been put in use.

I am familiar with one case where a Company in one Plant spent upwards of three-quarters of a million dollars to improve and add to the sanitary and safety conditions of their manufacturing plant, and, believing that what had been accomplished would be of interest to the general public, a certain important periodical was requested to send one of its writers for the purpose of describing the new features that had contributed so much to the comfort and safety of their employees. After spending several days in and around the Plant this writer retired with such information as would have enabled him to write a most interesting article, but instead of giving what would have been of interest and value to the public and other concerns interested in similar work, when the article actually appeared there was scarcely mention made of the many features that had been introduced. The improvements had been passed over with hardly complimentary mention, but the conditions under which some of the foreigners in the neighborhood lived were extensively commented upon and the Company severely criticised for allowing such a condition to exist in a community where their plant was located.

We can only account for such action as this on the part of the social writers on the ground that they give the public what is the most popular, and so long as the public is uninformed we can expect nothing more than sensationalism on the part of those who make a living by these methods.

It is, therefore, the duty of such organizations as The Railway Club of Pittsburgh, which stands second to none of similar organizations in the Country, to give greater consideration to just such subjects, and be prepared to point with pride to what has been done by corporations that its members represent, as this Club is composed of representatives of railways and manufacturing corporations. I know of no organization better pre-

pared to point out to the world the part that Pittsburgh and the Pittsburgh District has taken, in conjuncion with the Railways, to promote the welfare and safety of the traveling public and the employees of railways and the workshops of America.

It was here in Pittsburgh, as I have already stated, that the Air Brake—the first railway safety device—was conceived, developed and perfected by Mr. Geo. Westinghouse, the founder of all the Companies that bear his name. It was here that the Automatic Coupler was developed and perfected and through its adoption by the progressive railways of the country it became a common standard, so that now any car, whether passenger or freight, can be operated and coupled with absolute interchangeability on any railroad in the United States, regardless of location. It was in the Pittsburgh District that the first Automatic Block System, the importance of which we have lately read so much about, and which has been adopted so extensively throughout the Country, was conceived and put into use. It was the genius of Pittsburgh that designed and built the first steel freight car, which has been so universally adopted by the American Railways. It was also here that the first steel passenger coach was designed, built and put into use on a railway running out of Pittsburgh. It was here that the first solid steel wheel, the need of which became imperative owing to the heavy weight of the freight cars, was developed and perfected. All of these, however, would have been for naught had it not been for the designing and perfecting of the heavy steel rail that made the use of this equipment possible.

I might go on in this way and enumerate many other safety features in connection with the railroads, which have contributed largely to the safety and comfort of the traveling public and the employees of railways, to say nothing of what has been developed in the workshops and laboratories of the district, all of which tend to add health, comfort and protection to the employees of the industrial institutions of the community. (Applause)

PRESIDENT: I notice next on the Program is remarks by your President:

It is not my intention in responding to this number on the program to take up much of your time. It seems, however, appropriate to briefly speak of the Club and its success.

Organized October 1901 with only a few members it has grown so that its active members in good standing now numbers 1001 and while in membership it ranks below the Railway Clubs in New York and Chicago it ranks first in the number of recommended practices being adopted by Railroad Associations. Its Committees have always responded to every call made upon them, giving cheerfully and liberally of their time in order to make their work a success. This days outing, arranged by an appointed Committee consisting of Messrs Howe, Redding, McFeatters, Stark and Mason shows the character of the work done, and the attendance here today shows the appreciation of the Club members.

We have had today an opportunity to visit one of the largest and best equipped plant of its kind in the world; one whose products have made possible the running of heavy trains with speed and safety. Our host, The Westinghouse Air Brake Company, through its Vice President and General Manager, Mr. A. L. Humphrey, with his staff, have generously given the members of this Club, their wives (present and prospective) and friends, their time and hospitality. They have entertained us in such a way as to make our recollections thereof one long to be remembered. It seems, therefore, proper for us to give some expression of our apprciation of the courtesies thus extended to us this day, and I will ask all who would like to thank our host to stand. Mr. Humphrey—this expression of thanks is not only for our host, The Westinghouse Air Brake Company, but to you personally as a fellow member of the Club.

After the above remarks by Mr. Mitchell the following Program was rendered with the exception of the first three numbers which has already been heard:

PROGRAM.

Overture.....................*by* WESTINGHOUSE ORCHESTRA
"Goddess of Night" *by T. E. Allen*

Welcome..............................A. L. HUMPHREY,
Vice President and General Manager.

Remarks..............................A. G. MITCHELL,
President, The Railway Club of Pittsburgh.

Selection.....................*by* WESTINGHOUSE ORCHESTRA
"Northern Lights" *by J. Faure*

Vocal Solo.............MRS. WILLIAM CHRISTOPHER DIERKS

Accompanist, MISS FLORENCE BURGOYNE

(*a*) "A Birthday," *by R. Huntingdon Woodman*

(b) "O Come With Me in the Summer Night,"

by F. Van der Stricken

Violin Solo............................P. L. CRITTENDEN

"Le Deluge," *by C. Saint Saens*

Stereoptican Views

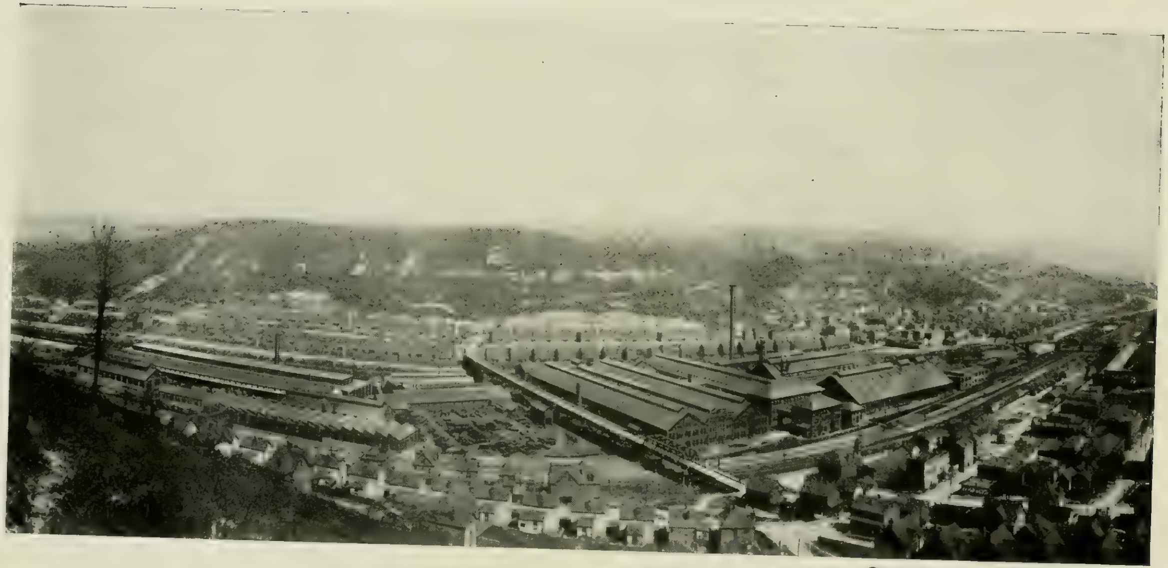
(Motion pictures taken and prepared by

W. A. B. Co. Photographic Dept.

The day of outing and entertainment was enjoyed and very much appreciated by those present and after wising Mr. Humphrey and his staff officers good night the party returned to Pittsburgh by special train leaving Wilmerding at 9:55 p. m.

J. B. Anderson

Secretary.



WESTINGHOUSE AIR BRAKE CO. WORKS,
Wilmerding, Pa.

WELFARE BUILDING,
Where Meeting Was Held.

SOME OF THE GUESTS

HISTORICAL NOTE.

The Westinghouse Air Brake Company was organized in 1869 and is the oldest of the Westinghouse group of industries. It began business in that part of Pittsburgh, formerly known as Allegheny, with a very small force, and in 1890 moved to a site fifteen miles east of Pittsburgh, where it founded the town of Wilmerding. The business has grown steadily from year to year, so that at the present time the works and yards of the Westinghouse Air Brake Company occupy about thirty acres, including over twenty acres of floor space.

The first train equipped with air brakes was the Steubenville Accommodation, on the P. C. C. & St. L. Ry., in 1869. On the trial run the superiority of the air brake over the hand brake was so forcibly demonstrated that it was not long until numerous roads in various parts of the United States began to apply it to their rolling stock, and today it is the standard brake appliance on practically every railroad in this as well as in most foreign countries. The air brake, conceived in the fertile brain of the man whose name will ever be linked with it, has played a most important part in the material progress of the world and occupies a worthy place among the foremost inventions of all ages.

PRODUCTS.

Aid Brakes for steam locomotives.

Air Brakes for electric cars in urban, interurban, elevated and subway service.

Air Brakes for electric locomotives.

Friction Draft Gear for railroad service.

Steam Driven, Motor Driven and Belt Driven Compressors, Governors and Accessories for industrial service.

Air Storage Reservoirs—Enameled, Riveted, Wielded and Brazed.

Air Brake Repair and Restandardizing work of all kinds.

Air Brake Conversions from old to new types.

ITEMS OF SPECIAL INTEREST.

Capitalization, $14,000,000. Capacity, over 1,000 sets of brake equipment per day. Largest brake building plant in the world. Total number of employees, 4,500. Monthly pay roll, $300,000. Shipments of finished product per month, 200 to 250 car loads.

TESTING.

In the manufacture of apparatus so important as the air brake, and because of the vital service it is designed to render, rigid standards and accurate workmanship are absolutely essential. To this end we have provided unequaled facilities for testing product, and both Exhibition and Shop Individual Racks are the most elaborate and complete in existence.

STATISTICS.

Over 2,886,000 freight and passenger cars and 78,400 locomotives in this country alone have been equipped with Westinghouse Brakes; and Westinghouse Friction Draft Gear has been applied to over 300,000 cars and 6,000 locomotives.

ADMINISTRATION.

The General Office Building of the Westinghouse Air Brake Company is located in the center of the town of Wilmerding, opposite the works. The arrangement and equipment of this building is thoroughly modern in every way. Visitors are always welcome.

POWER PLANT.

The first commercial Westinghouse-Parsons steam turbines built in this country are running in the Power Plant, which now consists of five 400-kilowatt Turbo-Generator Units and one 2000-kilowatt Turbo-Generator Unit. The current is distributed to about 288 induction motors throughout the works, aggregating 3560 H. P. All line shafting and power applications throughout the shops are motor driven.

IRON FOUNDRY.

One of the most interesting and unique departments of the works is the Iron Foundry, where iron is poured continually, the moulds being set on movable tables which pass in front of the moulding machines, core setters, cupolas and cleaning floor. The daily capacity of the foundry is approximately 500 tons. About 1,000 men are employed in this department of the plant.

The main foundry is equipped with four moulding tables, each about 250 feet long and moving around an oval track. Two of these tables move continuously and are used for small castings such as one man can handle readily. The other two tables are for heavy work, that is reservoirs, brake cylinders, and com-

pressor cylinders, and move forward only as each lot of moulds is finished. The cupola is located at one end and inside of the oval track. The method of operation is as follows:

As the table passes the line of moulding machines the empty flasks are removed and the moulder places his moulds on the moving platform. When the moulds reach the cupola, men mount the platform and pour melted iron from ladles which swing from overhead runways—ladle, man and mould moving along together. At the opposite end of the oval track is the "cleaning floor," or iron grating, upon which the now chilled castings are dropped as the platform passes this point, the empty flasks being again placed upon the platform ready for another set of moulds. The sand from the rough castings falls through the iron grating and is carried by a conveyor to a "mixer," where water and new sand are added. A second conveyor, passing overhead, carries this fresh mixture when thoroughly cooled to the moulding machines which are operated by hydraulic pressure.

BRASS FOUNDRY.

The Brass Foundry is connected with and located at the back of the Iron Foundry. The metal is melted in one 1000-pound and eight 650-pound Schwartz furnaces.

Every casting of iron or brass is finished in the Machine Shops adjoining the foundries.

INDUSTRIAL RAILWAY.

An industrial railway comprising about 6,000 feet of track connects the various buildings and yards. The motive power for this system is supplied by Milwaukee Gasoline Motor Driven Locomotives. Steam railway connections are also made with the Pennsylvania Railroad and the Westinghouse Inter-Works Railway.

FACTS ABOUT THE AIR BRAKE.

The function of the air brake is two-fold—first, to stop the train in the shortest possible distance when necessary; and, secondly, to enable short, smooth and accurate stops in regular operation.

Considering the investment, no part of the railway equip-

ment will give greater material returns than the air brake when properly installed, operated and maintained.

The air brake makes possible the hauling of heavier cars and longer trains—in fact, makes the heavy—high-tonnage—capacity freight train a possibility.

The air brake makes possible faster and more frequent passenger service—as much or more than powerful locomotives or a good road-bed—because train control is just as vital as tractive power.

The air brakes are much more powerful than the locomotive that pulls the train. A heavy passenger locomotive requires 10 minutes in time and perhaps 6 miles in distance to develop energy that the train brakes will dissipate in 20 seconds and within a distance of from 1,000 to 1,200 feet.

The following comparison shows conditions affecting train control in the early days of the air brake and what is involved today in meeting the wonderful changes that have taken place in maximum weights of locomotives and cars, train speeds, train frequencies, etc., changes which were made possible and practicable largely by the air brake:

	In 1869.	In 1911.
Weight of locomotives on drivers	50,000 lbs.	550,000 lbs.
Total weight of locomotives.....	90,000 lbs.	616,000 lbs.
Light weight of freight cars....	9,000 lbs.	52,000 lbs.
Carrying capacity of freight cars	14,000 lbs.	150,000 lbs.
Number of cars in freight trains	15	130
Length of freight trains.......	450 feet	4,550 feet
Carrying capacity of freight trains	300 tons	6,000 tons
Weight of passenger cars.......	20,000 lbs.	175,000 lbs.
Schedule speeds of passenger trains	30 m. p. h.	60 m. p. h

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OFFICIAL PROCEEDINGS

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$1.00 Per Year   20¢ Per Copy

Vol. XII.   OCTOBER 24, 1913   No. 9.

ANNUAL MEETING, ELECTION OF OFFICERS, SMOKER, CONSTITUTION, BY-LAWS AND NAMES OF MEMBERS

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OFFICIAL PROCEEDINGS

OF

The Railway Club of Pittsburgh

Organized October 18, 1901.

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Meetings held fourth Friday of each month, except June, July and August.

PROCEEDINGS OF MEETING, OCTOBER 24th, 1913.

The regular monthly meeting was called to order by the President, Mr. A. G. Mitchell, at the Monongahela House, Pittsburgh, Pa., at 8 o'clock P. M.

The following gentlemen registered:

MEMBERS.

Adams, Lewis
Albree, C. B.
Alleman, C. W.
Amsbary, D. H.
Anderson, A. M.
Anderson, D. W.
Anderson, J. B.
Antes, Edwin L.
Babcock, F. H.
Backoski, J. G.
Bailey, R. E. L.
Baldwin, G. C.
Balsley, Wm.
Barney, Harry E.
Barth, J. W.
Battinhouse, J.
Bealor, B. G.
Beebe, Ira L.
Beltz, J. D.
Berghane, A. L.
Bernard, R. Y.
Blackall, R. H.
Bond, W. W.
Boyer, Chas. E.
Boyle, H. E.
Brewer, W. A.
Brown, J. Fred.
Brown, John T. Jr.
Brownscombe, G. J.
Buckbee, W. A.
Bugle, Geo.
Burry, V. J.
Byron, A. W.
Chittenden, A. D.
Clark, C. C.
Clifford, M. J.
Cline, W. A.
Coates, H. T. Jr.
Code, J. G.
Conner, W. P.
Conway, J. D.
Cooper, F. E.
Cooper, Wm. M.
Cotton, A. C.
Coulter, A. F.
Cover, N. Cliffe
Craig, E. M.
Crenner, J. A.
Dalton, C. R.
Deane, Robt.
Deneke, W. F.
Dobson, O. C.
Dorr, C. O.
Drake, Thos. E.
Drake, W. C.
Duggan, E. J.
Dunlevy, J. H.
Easter, D. M.
Edwards, G. H.
Felton, F. J.
Flaherty, P. J.
Forsythe, Geo. B.
Freshwater, F. H.
George, M. E.
Geddes, Jas. R.
Gies, Geo. E.
Gillespie, W. J.
Glass, H. M.
Goetz, H. L.
Gowdy, H. K.
Green, H. W.
Grewe, H. F.
Gross, C. H.
Guay, J. W.

Hackenburg, J. H.
Hair, H. J.
Hammond, H. S.
Hardman, H. J.
Harner, A. J.
Hays, M. D.
Herrold, A. E.
Higgins, H. L.
Hoffman, C. T.
Howe, D. M.
Howe, Harry
Huff, Geo. F. Jr.
Hughes, J. E.
Hurley, Theo.
Hyndman, F. T.
Haynes, J. E.
James, J. H.
James, Robt. E.
Jefferson, E. Z.
Kelly, H. B.
Kensinger, E. A.
Keptner, J. B.
Kessler, H.
Kinter, D. H.
Kinch, L. E.
Kleine, R. L.
Knickerbocker, A. C.
Knight, E. A.
Koch, H. J.
Koch, Felix
Krebs, G. W.
Lakin, J. H.
Lansberry, W. B.
Laughlin, C. W.
Laughlin, E. J.
Laylin, M. H.
Leslie, S. I.
Lewis, A. J.
Lewis, Thos. L.
Livingston, B. F.
Low, J. R.
MacQuown, H. C.
Macfarlane, W. E.
Mackert, A. A.
Martin, T. J.
Maxfield, H. H.
Middlesworth, G. E.
Miller, Chas. R.
Millar, C. W.
Miller, F. L.
Mitchell, A. G.
Murphy, W. J.
McAbee, W. S.
McAlpine, J. H.
McCauley, Wm.
McConnell, P. L.
McCollum, Geo. C.
McIntyre, G. L.
McCully, John
McCurdy, C. E.
McFeatters, F. R.
McFarland, H. L.
McGrory, Percy
McKeen, J. W.
McNaight, A. H.
McNulty, F. M.
McVicar, G. E.
Neal, J. T.
Oates, Geo. M.
Orbin, Geo. N.
Orchard, Chas.
Orner, M. T. S.
Overly, C. F.
Partridge, F. G.
Parke, F. H.
Perry, W. E.
Pfeil, John
Porter, H. V.
Postlethwaite, C. E.
Pratt, I. D.
Proven, John
Pulliam, O. S.
Purdy, W. F.
Pyle, P. S.
Rabold, W. E.
Raser, Geo. B.
Ream, A. H.
Riley, T. T.
Redding, D. J.
Rea, C. S
Reymer, C. H.
Robbins, F. S.
Ross, C. B.
Root, E. E.
Runser, K. W.
Ryan, Wm. F.
Sargent, L. L.
Schauer, A. J.

Scheck, H. G.
Schomberg, W. T.
Shallenberger, C. M.
Shourek, T. L.
Shook, A. A.
Shook, H. J.
Shook, S. D.
Shuck, Wm. C.
Shremp, J. A.
Sigafoos, Gus.
Smith, John B.
Smith, M. A.
Snyder, J. W.
Stevens, C. W.
Stoddart, W. G.
Stucki, A.
Suckfield, G. A.
Sullivan, W. H.
Summers, J. M.
Swartz, H. E.
Swope, B. M.
Tamkins, B. L.
Taylor, F. C.
Taylor, H. G.
Thomas, J. H.
Thomas, E.
Thurlby, A. R.
Toomey, J. J.
Trappe, W. C.
Tucker, J. L.
Turner, W. V.
Voigt, A. J.
Walter, W. A.
Walther, G. C.
Ward, R. H.
Wescoe, F. B.
White, F. L.
Williams W. W.
Wittig, Wm.
Wolfe, L. L.
Wood, Ralph C.
Wood, V. V.
Woodside, S. P.

VISITORS.

Allen, E. K.
Bane, W. M.
Booker, G.
Brand, Theo.
Brinker, C. M.
Bullock, T. E.
Burket, H. O.
Butler, W. J.
Cain, Theo.
Cameron, S.
Canfield, L. T.
Cole, O. O.
Courtney, H.
Cullen, J. C.
Dalzell, John T.
Dette, R. E.
Donovan, P. H.
Dorr, H. C.
Dougherty, John
Early, John N.
Ehman, A. J.
Elder, Thos. W. Jr.
Ewing, W. G.
Farrel, H. L.
Ferguson, O. G.
Fogle, Emmett
Gibson, William
Gilg, H. F.
Gilsdorf, D.
Goffe, Wm. F.
Gormley, J. A.
Grafinger, Jos.
Gray, John Jr.
Hahn, Harry H.
Harshman, R. M.
Hathaway, J. W.
Hazen, J. C.
Herbick, Nicholas
Hickman, C. P.
Hink, Geo. L.
Humes, H. L.
Hunter, D. C.
Irwin, E. W.
Jacobs, David
Jefferson, H. F.
Johnston, W. K.

Kalig, W. P.
Skarry, John
Keyser, R. H.
Kleine, A. Albert
Koll, Jacob F.
Kofphar, Milton
Kulonsck, V.
Laughlin, Jas.
Laughner, C. L.
Lee, S. M.
Lindner, W. C.
Logsdon, J. T.
Lowther, Geo.
Love, J. A.
Lutes, W. P.
Maconbray, R. J.
Meehan, P. J.
Miles, C. B.
Miller, J. H. Jr.
Mills, C. C.
Mock, R. H.
Morris, W. R.
Musgrave, Geo. H.
Myers, C. A.
McCredie, Jas.
McCollum, Wm. H.
McKinstry, C. H.
Nelan, E. J.
Orbin, J. N.
O'Brien, Thos. J.
Oswald, J. N.
Parry, R. H.
Patterson, S. E.
Penn, Wm.
Perry, S. F.
Radcliff, J. R.
Rebstock, J. B.
Rossiter, A. L.
Rath, Phillip J.
Schweitzer, A. C.
Sergent, Chas. F.
Seiler, E. J.
Shook, Jacob
Sitterly, W. H.
Small, B. R.
Smith, E. M.
Smoot, W. D.
Sneary, L. A.
Stephany, F. J.
Stoehr, P. A.
Stone, Dr. P. R.
Streib, J. F.
Summers, J. R.
Tate, J. B.
Tracy, J. B. A.
Trust, C. W.
Ulmer, E. F.
Waggoner, R. E.
Wardale, N. H.
Wardley, Jas.
Wassell, H. B.
Watson, G. H.
Westervelt, H. C.
Wilson, H. H.
Witherspoon, J. N.
Williamson, J. A.
Wright, J. B.
Yawman, C. A.

PRESIDENT MITCHELL: Gentlemen, It is very gratifying to see so many here tonight. We hope that everybody will go away feeling that they have had a very pleasant evening.

The roll call will be dispensed with, as we have a record of the attendance on the registry cards.

The reading of the minutes will be dispensed with, as the proceedings of the last meeting are in print and will be in your hands by tomorrow morning.

The Secretary will read the list of applications for membership.

SECRETARY ANDERSON: I have the following applications for membership, which are in proper form:

Anwyll, Arthur R., Estimator, Pressed Steel Car Co., Kenmore Apartment, Avalon, Pa. Recommended by Harry Howe.

Arnold, R. R., General Foreman, Pressed Steel Car Co., Benton Ave., Pittsburgh, Pa. Recommended by Harry Howe.

Baker, Emmett C., Clerk, Union R. R., 325 Larimer Ave., Turtle Creek, Pa. Recommended by J. W. Wyke.

Battenhouse, Wm., General Car Inspector, B. & O. R. R., Glenwood, Pittsburgh, Pa. Recommended by M. O'Connor.

Brunner, F. J., Auditor, Wabash-Pittsburgh Terminal Ry., 521 Wabash Building, Pittsburgh, Pa. Recommended by C. R. Cassiday.

Butler, W. J., Enginehouse Foreman, Monongahela R. R., Box 719, South Brownsville, Pa. Recommended by E. E. Root.

Casey, P. H., Chief Clerk, Pressed Steel Car Co., 28 East Orchard Ave., Bellevue, Pa. Recommended by Harry Howe.

Cato, J. R., Foreman Stores Department, Pressed Steel Car Co., 622 Center Ave., Avalon, Pa. Recommended by Harry Howe.

Chapman, B. D., Machinist Foreman, Pressed Steel Car Co., McKees Rocks, Pa. Recommended by Harry Howe.

Connell, J. H., Agent, P. R. R., Cresson, Pa. Recommended by C. T. Hoffman.

Donovan, P. H., Mechanical Engineer, Westinghouse Air Brake Co., Wilmerding, Pa. Recommended by W. V. Turner.

Duer, H. I., Ticket Seller, P. R. R., 339 Collins Ave., Pittsburgh, Pa. Recommended by V. V. Wood.

Dugan, Hugh A., Yard Master, Monongahela Connecting R. R., 4640 Chatsworth Ave., Pittsburgh, Pa. Recommended by William Burke.

Ferguson, R. B., Clerk to Supt. Monon. Conn. R. R., 4439 Chats-

worth Ave., Pittsburgh, Pa. Recommended by F. M. McNulty.

Fluent, B. F., Engine Dispatcher, B. & L. E. R. R., Box 42, North Bessemer, Pa. Recommended by J. W. Wyke.

Frasher, John D., Inspector, Pressed Steel Car Co., 613 Arch St., N. S., Pittsburgh, Pa. Recommended by Harry Howe.

Grafinger, Joseph, Time Clerk, Monon. R. R., 206 Front St., Brownsville, Pa. Recommended by C. O. Dorr.

Greiff, J. C., Draftsman, Pressed Steel Car Co., 701 Broadway, West Park, McKees Rocks. Recommended by Harry Howe.

Herbick, Nicholas, Vice President, Simplex Air Brake Co., 441 Orchard Ave., Bellevue, Pa. Recommended by D. C. Courtney.

Hill, J. F., Master Mechanic, P. & L. E. R. R., Brewster, Ohio. Recommended by F. T. Hyndman.

Hoover, E. J., General Foreman Forge Department, Pressed Steel Car Co., 75 Kendall Ave., Bellevue, Pa. Recommended by Harry Howe.

Johnson, A. B., Representative Standard Steel Car Co., Frick Building, Pittsburgh, Pa. Recommended by A. Stucki.

Jones, A. W., Chief Engineer, Montour R. R., Oliver Building, Pittsburgh, Pa. Recommended by F. H. Stark.

Kelley, J. B., Manager, Monongahela House, Pittsburgh, Pa. Recommended by D. M. Howe.

Kiely, John J., Chief Yard Clerk, P. R. R., 5422 Carnegie Ave., Pittsburgh, Pa. Recommended by H. J. Shook.

Knowlton, E. A., Manager, Schutte & Koerting Co., 1710 Keenan Building, Pittsburgh, Pa. Recommended by A. A. Shook.

Krahmer, E. F., Supervising Agent, P. R. R., 3000 Sarah St., South Side, Pittsburgh, Pa. Recommended by H. G. Scheck.

Laughner, Carl L., General Foreman, Pressed Steel Car Co.,

609 Sandusky St., Pittsburgh, Pa. Recommended by Harry Howe.

Lindner, W. C., Foreman Car Repairs, P. R. R., Elrama, Pa. Recommended by G. C. Walther.

Lindstrom, F. J., Draftsman, Pressed Steel Car Co., 477 Lobinger Ave., Braddock, Pa. Recommended by Harry Howe.

Livingston, E. M., Special Duty, P. R. R., c-o General Superintendent Motive Power, Altoona, Pa. Recommended by John P. Neff.

Mitchell, Harry T., Chief Clerk, Assistant Train Master, P. R. R., 304 Main St., Pittsburgh, Pa. Recommended by H. J. Shook.

Miyasaki, Yuske, Draftsman, Pressed Steel Car Co., Engineering Department, McKees Rocks, Pa. Recommended by Harry Howe.

Monahan, E. J., Chief Clerk to Master Mechanic, P. R. R., Verona, Pa. Recommended by W. A. Walter.

Montgomery, S. F., Assistant Store Keeper, P. R. R., Box 241, Pitcairn, Pa. Recommended by C. T. Hoffman.

Morris, Wm. R., Clerk, Pressed Steel Car Co., 419 Forest Ave., Bellevue, Pa. Recommended by Harry Howe.

McKee, R. R., Store Keeper, Pressed Steel Car Co., 841 Rebecca St., N. S., Pittsburgh, Pa. Recommended by Harry Howe.

McKinstry, C. H., Assistant to Engineer of Tests, Westinghouse Air Brake Co., 674 Middle Ave., Wilmerding, Pa. Recommended by J. Battenhouse.

Nelan, E. J., Car Department Clerk, Monon. R. R., Brownsville, Pa. Recommended by D. H. Kinter.

Otting, Harry J., Draftsman, M. M. Dept., Pressed Steel Car Co., 616 Cliff St., Bellevue, Pa. Recommended by Harry Howe.

Smith, M. D. K., Supervisor, P. R. R., Brownsville, Pa. Recommended by H. G. Scheck.

Stratman, L. J., Clerk, Purchasing Department Pressed Steel

Car Co., 157 South Bryant Ave., Bellevue, Pa. Recommended by Harry Howe.

Summers, Jos. R., Clerk, Purchasing Department, Pressed Steel Car Co., 523½ Herron Ave., Pittsburgh, Pa. Recommended by Harry Howe.

Swayne, H. B., Assistant Superintendent, Pressed Steel Car Co., 311 McKinley Ave., Avalon, Pa. Recommended by Harry Howe.

Thomas, William, Foreman, Pressed Steel Car Co., 1312 Woods Run Ave., N. S., Pittsburgh, Pa. Recommended by Harry Howe.

Trautman, Jacob, Sales Manager, Colonial Steel Co., 3647 Wealth St., N. S., Pittsburgh, Pa. Recommended by F. E. Cooper.

Ulmer, E. F., Estimator, Boiler and Tank Department, American Locomtive Co., 1304 California Ave., N. S., Pittsburgh, Pa. Recommended by Wm. Wittig.

Waggoner, R. E., Chief Engineer, Carnegie Steel Co., Clark Mills, 3514 Penn Ave., Pittsburgh, Pa. Recommended by S. D. Shook.

Wardale, Norman H., Draftsman, Pressed Steel Car Co., 1012 Criss St., Sheridanville, Pittsburgh, Pa. Recommended by Harry Howe.

Woernley, H. F., Assistant Chief Engineer, Westinghouse Air Brake Co., Wilmerding, Pa. Recommended by W. V. Turner.

This brings our membership up to 1052.

PRESIDENT: As soon as these applications have been favorably passed upon by the Executive Committee the gentlemen will become members. Next will be communications, which I will ask the Secretary to read.

MR. D. J. REDDING: Mr. President, for fear that Mr. Harry Howe, who appears as recommender on a large proportion of the applications for membership, just read, may think that we do not appreciate his efforts, I move that we express a vote of confidence in Mr. Howe.

The motion was carried amid loud applause.

SECRETARY: I have a communication from our retired Treasurer, Mr. J. D. McIlwain, expressing his thanks and appreciation at having been elected the first honorary member of the Club.

PRESIDENT: We have some unfinished business which was left over from the last meeting, and I will ask the Secretary to present it.

SECRETARY: At the last meeting the following Resolution was offered, and held over under the rules until this meeting for action.

"In view of the increase in membership in The Railway Club of Pittsburgh during the past few years it is felt at this time that some of the Committees elected by the members of the Club should be increased in number. Therefore, we the undersigned members of the Club offer the following amendments to the Constitution:

> ART. 4, Officers—That the Finance Committee consist of five members instead of three. That the Membership Committee consist of seven members instead of five, and that a Committee to be known as an Entertainment Committee consisting of three members be added.
>
> Add to ART. 5, SEC. 8, as follows: The Entertainment Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents and such other duties as may be proper for such a Committee."

PRESIDENT: Under the Constitution, action on these amendments is proper at this time. What do you wish to do with this resolution?

MR. REDDING: I move that the recommendations be accepted and the amendments adopted.

The motion was duly seconded and carried by unanimous vote.

PRESIDENT: Next we will listen to the Annual Report of the Secretary.

SECRETARY'S REPORT

To the Officers and Members of
The Railway Club of Pittsburgh,

Gentlemen:

I submit below a statement of the events closing the twelfth year of the Club.

During the year death has removed from our midst the following members: M. A. Malloy, C. L. Hinsdale, John T. Brown and George H. Smith.

The support given by our advertisers is very much appreciated. We have increased the number of advertisers by six and lost but one.

I feel that the subjects presented at the several meetings were of interest because of the large attendance at these meetings and the fact that numerous requests have been received from all over the United States and abroad for copies of the Official Proceedings.

I, as Secretary, appreciate the co-operation and support of the members and officers and while some of our members may have censured me for hounding them to pay up their dues I feel that it is your duty as well as mine in order to properly conduct the business of the Club and make it a success.

The following is a summary of the membership, financial condition, etc., for the year up to and including this meeting:

Membership

Reported last year	949	
Received into membership during the year	210	
Reinstated	2	
		1161
Suspended for non-payment of dues	83	
Resigned	16	
Loss of address	6	
Removed by death	4	
		109
Present membership		1052

FINANCIAL

Receipts

In hands of Treasurer last year	$2427.48	
From dues	2634.00	
From advertising	1750.02	
From sale of Official Proceedings and other sources	415.70	
		$ 7,227.20

Disbursements

Printing Proceedings, Advance sheets, notices and postage	$2515.09	
Hotel, lunch, etc	664.79	
Premium on Bonds of Secretary and Treasurer	28.00	
Secretary's expenses to Atlantic City, M. C. B. and M. M. Convention	50.00	
Cigars for Club meetings	117.78	
Stereopticon light	30.00	
Stationery and supplies	197.81	
Messenger service	24.00	
Entertainment	270.20	
Floral emblems	17.00	
Secretary's salary 1912-1913	500.00	
Reporting Proceedings	105.00	
Contribution to Relief Fund for flood sufferers	100.00	
		$ 4,619.67
Balance in hands of Treasurer		$ 2,607.53

Respectfully submitted,

J. B. Anderson,
Secretary.

PRESIDENT: Next will be the Annual Report of the Treasurer, Mr. F. H. Stark.

TREASURER'S REPORT

To the Officers and Members
The Railway Club of Pittsburgh,

Gentlemen:

I beg to submit the following report for the year ending October 24, 1913:

Receipts

Balance on hand from last year.............	$2427.48	
Received from the Secretary during the year	4764.45	
Interest on checking account...............	5.10	
Interest on savings account of $1,000.00....	30.17	
Total		$ 7,227.20

Disbursements

Paid out on Secretary's checks and vouchers.	$4,619.67
Balance on hand....................	$ 2,607.53

Respectfully submitted,

F. H. Stark,
Treasurer.

PRESIDENT: Both of these reports will be referred to the Executive Committee for consideration.

Next we will have the report of the Executive Committee, giving the result of the election of officers.

MR. REDDING: Mr. President and Gentlemen, we have the honor to report that the total number of ballots cast was 324, and the following gentlemen were unanimously elected:

President, A. G. Mitchell, Supt. Monongahela Division, Penna. R. R.

First Vice President, F. M. McNulty, Supt. Motive Power, Monon. Con. R. R.

Second Vice President, J. G. Code, General Manager, Wabash-Pittsburgh Terminal Ry.

Secretary, J. B. Anderson, Chief Clerk, Supt. Motive Power, Penna. R. R.

Treasurer, F. H. Stark, Supt. Montour R. R.

Executive Committee, L. H. Turner, Supt. Motive Power, P. & L. E. R. R.; D. J. Redding, Asst. Supt. Motive Power, P. & L. E. R. R.; F. R. McFeatters, Supt. Union R. R.

Finance Committee, D. C. Noble, President Pittsburgh Spring & Steel Co.; E. K. Connelly, Purchasing Agent, P. & L. E. R. R.; C. E. Postlethwaite, Manager Sales, Pressed Steel Car Co.; A. L. Humphrey, Vice President and General Manager, W. A. B. Co.; L. C. Bihler, Traffic Manager, Carnegie Steel Co.

Membership Committee, D. M. Howe, Manager, Jos. Dixon Crucible Co.; H. H. Maxfield, Master Mechanic, Penna. R. R.; Chas. A. Lindstrom, Asst. to President, Pressed Steel Car Co.; A. Stucki, Engineer; C. O. Dambach, Supt. Wabash-Pittsburgh Terminal Ry.; O. S. Pulliam, Secretary Pittsburgh Steel Foundry Co.; Frank J. Lanahan, President Fort Pitt Malleable Iron Co.

Entertainment Committee, Stephen C. Mason, Secretary, The McConway & Torley Co.; R. H. Blackall, Railway Supplies; D. H. Amsbary, Manager, Dearborn Chemical Co.

PRESIDENT: Mr. Code, the gentlemen who has been elected to the office of Second Vice-President, is in the room and I want him to come forward and let the members see and

hear him. I want you all to be acquainted with him. He is General Manager of the Wabash-Pittsburgh Terminal Ry and you will find him a good fellow.

MR. J. G. CODE: Mr. President and gentlemen I do not know why I should be the only one in the parade.

PRESIDENT: Because all the others are old timers.

MR. CODE: May be I am not! One of my very good friends assured me that the position of Second Vice-President of this Club carried with it the maximum of honor a minimum of work and no salary.

I certainly appreciate the honor, and thank you for it. As far as the work is concerned, I have been accustomed to work and will endeavor to pull my tonnage.

PRESIDENT: Gentlemen, the business of the evening having now been completed, this business meeting will be followed by a vaudeville entertainment, which will be under the charge of the Secretary. And I want to say that if the show isn't good, do not blame it on any executive officer, but charge the whole blame on the Secretary.

The meeting is now at the tender mercies of the Secretary.

SECRETARY: I will ask the gentlemen to give us their kind indulgence for a few minutes until I can have the stage prepared and the actors rounded up.

The following program was then rendered:

PROGRAM

Overture .... Orchestra
Stories and Song ....Mr. W. E. McClelland
The Debout Duo ....Refined Singing and Dancing Artists
Teddy Fields .... Monologist
Miss Ola Edeburn ....That Clever Dancing Artist
Harris & Stanley ....Singing and Talking Entertainers
Selection .... Orchestra

After this entertainment the Club adjourned. The following menu was then served to the members of the Club and visitors in the dining rooms:

MENU

RADISHES OLIVES

CHICKEN CROQUETTE WITH PEAS

ASSORTED SANDWICHES

CHARLOTTE RUSSE

COFFEE

This meeting was one of the largest ever held by the Club and was apparently enjoyed by all present. Each one was presented with a package containing a pipe, tobacco, pipe cleaners, cigar, stogies and a handsome morocco leather cigar case.

J. B. Anderson
Secretary.

SOCIETY OF RAILWAY CLUB SECRETARIES MEETING AND DINNER, JUNE 14, 1913.

The Seventh Annual meeting of the Society of Railway Club Secretaries was held Saturday, June 14th, 1913, at the Marlborough-Blenheim Hotel, Atlantic City, N. J., Mr. J. B. Anderson, Vice-Chairman, presiding.

The various Clubs enrolled were represented, as follows:

New York Railroad Club—Mr. Daniel M. Brady and Mr. Harry D. Vought.

Central Railway Club—Mr. W. F. Jones and Mr. Harry D. Vought.

The Railway Club of Pittsburgh—Mr. J. B. Anderson.

New England Railway Club—Mr. W. C. Cade, Jr.

Richmond Railroad Club—Mr. F. O. Robinson.

Southern and Southwestern Railway Club—Mr. A. J. Merrill.

Canadian Railway Club—Mr. James Powell.

The Society had as a delegate visitor, Mr. H. Boutet, Secretary of the Cincinnati Railroad Club, which had been invited to affiliate with the Society. Mr. Boutet stated that he was present for the purpose of becoming familiar with the work and objects of the organization, the advantages to be obtained by membership therein, and such other information as might be made the basis of a report to his Club.

Mr. Boutet was accorded a cordial welcome by Vice-Chairman Anderson in behalf of himself and his associates of the Society, and invited to address the meeting along lines relating to his attendance which he did to the pleasure and interest of his listeners.

Greetings were extended to his Club through him and the earnest wish expressed that its officers and members would find it to their interest to have the Cincinnati Club enrolled as a member of the Society.

Taking up the regular order of business, the reading of the Minutes of the meeting of 1912 was, on motion of Mr. Merrill, omitted, a copy in full having previously been supplied to each Secretary, and there being no errors or omissions, they were ordered approved.

The Secretary reported that Mr. George H. Frazier, Secretary of the New England Club and Chairman of the Society, had, during the year resigned his office in that Club and sent a message of good will and best wishes for the continued success and prosperity of the Society in a letter announcing the change. His successor was Mr. W. E. Cade, Jr., who was present at this time and Mr. Cade being duly introduced, was made welcome by the Chair.

The annual report of the Secretary-Treasurer being called for, Mr. Vought stated that no further progress had been made with respect to the resignation of the Western Railway Club which was laid upon the table when presented, but it was still hoped that the Club would, eventually be induced through its officers, to withdraw it.

In a conversation with Mr. Vought, Mr. Joseph W. Taylor, Secretary of that Club had indicated that in all probability this would be gained if the various clubs would agree to a restoration of the old method of a gratuitous interchange of Official Proceedings, whereby any member of a Club could receive these publications if he wanted them, without expense to himself, each Club to pay the Clubs furnishing them at actual cost.

Mr. Taylor had said that, in his opinion, which was sustained by the Directors of the Western Club, in office when its resignation from the Society was decided upon, this was the only distinct advantage to be obtained by membership in the Society, notwithstanding the publication of the Index of Subjects and the furnishing of a copy thereof to every member of a Club affiliated with the Society.

Mr. Vought further reported that the Northern Railway Club had failed to meet its obligations to the Society, which was partially responsible for the delayed issuance of the Index of Subjects for two years past, and there was reason to believe that it had no intention of continuing its affiliation owing to its weakened condition and which it was understood had practically put it out of existence.

The matter of organizing the proposed American Association of Railway Secretaries had been held in obeyance because conditions had not been propitious for consummating the object in view, but these had now changed and in all probability, a meeting to complete the organization would be held in November.

A matter of interest for the season of 1913-1914 was the fact that the meeting of the New York Railroad Club on the third Friday in November would be Railway Club Night, when Mr. Daniel M. Brady, the oldest ex-secretary of a railway organization living, would present a paper on "The Past, Present and Future of Railway Clubs." The tentative program for the occasion contemplated an invitation to the presidents and secretaries of all the railway clubs to dine with the Executive Committee of the New York Railroad Club and later at the meeting of the Club to which members of all clubs would be invited, asked to each engage in a five minute address germane to a discussion of Mr. Brady's paper.

Mr. Vought concluded his report with a statement of receipts and disbursements showing a small balance to the credit of the Society.

The report was received and approved, the members agreeing to take up with the executive committees of their respective clubs, the subject matter of the proposition made by Secretary Taylor of the Western Club and ask for action thereon.

On motion of Mr. Merrill, the Secretary-Treasurer was directed to provide Mr. Cade with an official badge of the Society, and authorized to do the same for Mr. Boutet, in case the Cincinnati Club affiliated with the Society.

On motion of Mr. Powell, it was ordered that at any time if the Northern or any other club failed to meet its obligations, or did not respond promptly to a request for its list of subjects, the Secretary-Treasurer will be authorized to proceed with his work and to drop them from the roll of membership.

Mr. Robinson suggested that conditions and experience hardly justified a continuance of either a formal dinner or luncheon in connection with the annual meetings of the Society. It had in fact been a subject of some criticism which had led him to bring it up at this time.

After considerable discussion pro and con a unanimity of sentiment for Mr. Robinson's ideas developed. On motion of

Mr. Merrill, seconded by Mr. Powell, it was agreed to abandon this as a distinctive feature of all future meetings with the reservation that members be entitled to meet socially on an independent basis with such guests as they might see fit to have with them at their own individual expense.

Bills aggregating $32.50 were ordered paid and approval given to expenditures made by the Secretary-Treasurer during the year for current expenses, and the printing of the Index of Subjects.

The annual assessment was fixed at $15 subject to acceptance by the Clubs. With the completion of the business docketed, the election of officers was held, with the following result, and the Society Adjourned.

Chairman—Mr. J. B. Anderson, Pittsburgh.

Vice-Chairman—Mr. A. J. Merrill, Atlanta, Ga.

Secretary-Treasurer—Mr. Harry D. Vought, New York City.

Respectfully submitted,

Harry D. Vought,
Secretary.

THE RAILWAY CLUB OF PITTSBURGH CONSTITUTION.

Article I.

The name of this organization shall be "The Railway Club of Pittsburgh."

Article II.

OBJECTS.

The objects of this Club shall be mutual intercourse for the acquirement of knowledge, by reports and discussion, for the improvement of railway operation, construction, maintenance and equipment, and to bring into closer relationship men employed in railway work and kindred interests.

Article III.

MEMBERSHIP.

Section 1. The membership of this Club shall consist of persons interested in any department of railway service or kindred interests, or persons recommended by the Executive Committee upon the payment of the annual dues for the current year.

Sec. 2. Persons may become honorary members of this Club by a unanimous vote of all members present at any of its regular meetings, and shall be entitled to all the privileges of membership and not be subject to the payment of dues or assessments.

Article IV.

OFFICERS.

The officers of this Club shall consist of a President, First Vice President, Second Vice President, Secretary, Treasurer, Finance Committee consisting of five members, Membership Committee consisting of seven members, Entertainment Committee consisting of three members, and three Elective Executive

Members who shall serve a term of one year from the date of their election, unless a vacancy occurs, in which case a successor shall be elected to fill the unexpired term.

Article V.

DUTIES OF OFFICERS.

Section 1. The President shall preside at all regular or special meetings of the Club and perform all duties pertaining to a presiding officer; also serve as a member of the Executive Committee.

Sec. 2. The First Vice President, in the absence of the President, will perform all the duties of that officer; the Second Vice President, in the absence of the President and First Vice President, will perform the duties of the presiding officer. The First and Second Vice President shall also serve as members of the Executive Committee.

Sec. 3. The Secretary will attend all meetings of the Club or Executive Committee, keep full minutes of their proceedings, preserve the records and documents of the Club, accept and turn over all moneys received to the Treasurer at least once a month, draw cheques for all bills presented when approved by a majority of the Executive Committee present at any meetings of the Club, or Executive Committee meeting. He shall have charge of the publication of the Club Proceedings and perform other routine work pertaining to the business affairs of the Club under the direction of the Executive Committee.

Sec. 4. The Treasurer shall receipt for all moneys received from the Secretary, and deposit the same in the name of the Club within thirty days in a bank approved by the Executive Committee. All disbursements of the funds of the Club shall be by cheque signed by the Secretary and Treasurer.

Sec. 5. The Executive Committee will exercise a general supervision over the affairs of the Club and authorize all expenditures of its funds. The elective members of this Committee shall also perform the duties of an auditing committee to audit the accounts of the Club at the close of a term or at any time necessary to do so.

Sec. 6. The Finance Committee will have general supervision over the finances of the Club, and perform such duties as

may be assigned them by the President or First and Second Vice Presidents.

Sec. 7. The Membership Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents, and such other duties as may be proper for such a committee.

Sec. 8. The Entertainment Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents and such other duties as may be proper for such a committee.

Article VI.

ELECTION OF OFFICERS.

Section 1. The officers shall be elected at the regular annual meeting as follows, except as otherwise provided for:

Sec. 2. Written forms will be mailed to all the members of the Club, not less than twenty days previous to the annual meeting, by the three elective members of the Executive Committee. These forms shall provide a method, so that each member may express his choice for the several offices to be filled.

Sec. 3. The three elective members of the Executive Committee will present to the President the names of the members receiving the highest number of votes for each office, together with the number of votes received.

Sec. 4. The President will announce the result of the ballot and declare the election.

Sec. 5. Should two or more members receive the same number of votes, it shall be decided by a vote of the members present, by ballot.

Article VII.

AMENDMENTS.

Amendments may be made to this Constitution by written request of ten members, presented at a regular meeting and decided by a two-thirds vote of the members present at the next regular meeting.

BY-LAWS.

Article I.

MEETINGS

Section 1. The regular meetings of the Club shall be held at Pittsburgh, Pa., on the fourth Friday of each month, except June, July and August, at 8:00 o'clock P. M.

Sec. 2. The annual meeting shall be held on the fourth Friday of October each year.

Sec. 3. The President may, at such times as he deems expedient, or upon request of a quorum, call special meetings.

Article II.

QUORUM.

At any regular or special meeting nine members shall constitute a quorum.

Article III.

DUES.

Section 1. The dues of members shall be $2.00 per annum, $1.00 of same to apply to subscription for Club Journal, payable in advance, on or before the fourth Friday of September each year.

Sec. 2. Each member will be assessed $1.00 extra annually to provide light refreshments for each meeting.

Sec. 3. At the annual meeting members whose dues are unpaid shall be dropped from the roll after due notice mailed them at least thirty days previous.

Sec. 4. Members suspended for non-payment of dues shall not be reinstated until all arrearages have been paid.

Article IV.

ORDER OF BUSINESS.

1—Roll call.

2—Reading of the minutes.

3—Announcements of new members.
4—Reports of Committees.
5—Communications, notices, etc.
6—Unfinished business.
7—New business.
8—Recess.
9—Discussion of subjects presented at previous meeting.
10—Appointment of committees.
11—Election of officers.
12—Announcements.
13—Financial reports or statements.
14—Adjournment.

Article V.

SUBJECTS—PUBLICATIONS.

Section 1. The Executive Committee will provide the papers or matter for discussion at each regular meeting.

Sec. 2. The proceedings or such portion as the Executive Committee may approve shall be published (standard size, 6x9 inches), and mailed to the members of the Club or other similar clubs with which exchange is made.

Article VI.

The stenographic report of the meetings will be confined to resolutions, motions and discussions of papers unless otherwise directed by the presiding officer.

Article VII.

AMENDMENTS.

These By-Laws may be amended by written request of ten members, presented at a regular meeting, and a two-thirds vote of the members present at the next meeting.

LIST OF MEMBERS

Adams, Chas. B.,
Engineer of Construction,
Pressed S. C. Co.,
Euclid Apts.,
Bellevue, Pa.

Adams, Lewis,
Clerk, P. S. Car Co.,
4004 Northminister St.,
N. S., Pittsburgh, Pa.

Albert, Leon H.,
Traveling Fireman,
Penna. R. R.,
Elrama, Pa.

Albree, Chester B.,
President, Chester B. Albree
Iron Works Co.,
1201 Metropolitain St.,
N. S., Pittsburgh, Pa.

Alexander, J. R.,
Gen'l R. F. of E.,
Pennsylvania R. R. Co.,
Altoona, Pa.

Alleman, C. W.,
Sup'r. of Stores,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Allen, Harry L.,
Ass't. 4th Vice Pres't,
American Steel Foundries,
Alliance, Ohio.

Allen, Jas. P.,
Vice President,
Union Steel Castings Co.,
61st and Butler Sts.,
Pittsburgh, Pa.

Allison, John,
Chief Engineer,
Pittsburgh Steel Fdy. Co.,
Glassport, Pa.

Altman, C. M.,
Asst. Foreman Car Insp.,
P. R. R. Co.,
R. F. D. No. 2,
Jeannette, Pa.

Amsbary, D. H.,
District Manager, Dearborn,
Chemical Co.,
Farmers Bank Building,
Pittsburgh, Pa.

Anderson, D. W.,
Mgr., Ry. Steel Spring Co.,
20th and Liberty Sts.,
Pittsburgh, Pa.

Anderson, Hans S.,
Asst. Mechanical Engineer,
H. K. Porter Co.,
225 Millvale Ave.,
Pittsburgh, Pa.

Anderson, J. B.,
C. C. to S. M. P., P. R. R. Co.,
207 Penna. Station,
Pittsburgh, Pa.

Anderson, J. P.,
Chief Draftsman,
P. S. Car Co.,
North Rebecca (near
Black St.),
Pittsburgh, Pa.

Andresen, A. M.,
Salesman, Chicago
Pneumatic Tool Co.,
No. 10 Wood St.,
Pittsburgh, Pa.

Andrews, Fred. G.,
Manager, Pittsburgh
Pit Post Co.,
Room 907 Arrott Bldg.,
Pittsburgh, Pa.

Angell, C. P.,
Train Master.
B. and O. R. R. Co.,
4611 2nd Ave.,
Pittsburgh, Pa.

Antes, Edwin L.,
Foreman Elect. Dept.,
Pressed Steel Car Co.,
McKees Rocks, Pa.

Anthony, J. T.,
Rep., American Arch Co.,
30 Church St.,
New York, N. Y.

Anwyll, Arthur R.,
Estimator, Pressed Steel Car Company,
Kenmore Apt.,
Avalon, Pa.

Arensberg, F. L.,
Asst. Mgr., McCullough-Dalzell Crucible Co.,
36th St. and A. V. Ry.,
Pittsburgh, Pa.

Arnold, R. R.,
Genl. Foreman, Pressed Steel Car Company,
Benton Ave.,
N. S., Pittsburgh, Pa.

Artzberger, L. C.,
Foreman,
H. K. Porter Co.,
5126 Dearborn St.,
Pittsburgh, Pa.

Ashcroft, Chas. D.,
Mgr., Hartford Steam Boiler Inspection & Insurance Co.,
614 Security Bldg.,
St. Louis, Mo.

Ashley, F. B.,
Special Agent, Penna Lines, West of Pgh.,
Room 724 Penna. Station,
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Ashworth, Wm.,
Salesman, Johnston, Morehouse, Dickey Co.,
P. O. Box 308,
Pittsburgh, Pa.

Atterbury, W. W.,
Vice President.
Pennsylvania R. R. Co.,
Philadelphia, Pa.

Atwood, J. A.,
Chief Engineer,
P. & L. E. R. R. Co.,
General Office.
Pittsburgh, Pa.

Averell, W. H.,
Asst. Gen. Supt.,
B. & O. R. R. Co.,
Pittsburgh, Pa.

Ayers, H. B.,
Gen. Mgr., H. K. Porter Co.,
49th St. and A. V. Ry.,
Pittsburgh, Pa.

Babcock, F. H.,
Boilermaker,
P. & L. E. R. R.,
938 W. Carson St.,
Pittsburgh, Pa.

Backoski, Jos. G.,
Clerk, P. R. R.,
5441 McCandless Ave.,
Pittsburgh, Pa.

Bailey, H. H.,
Yard Master,
P. R. R. Monon. Div.,
Monongahela, Pa.

Bailey, J. H.,
Foreman,
56th St. Works,
The McConway & Torley Co.,
Pittsburgh, Pa.

Bailey, R. E. L.,
Sec'y., American Spiral Spring and Mfg. Co.,
56th St. and A. V. Ry.,
Pittsburgh, Pa.

Baird, F. C.,
G. F. A., B. & L. E. R. R.,
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Pittsburgh, Pa.

Baker, B. R.,
Mgr., Gulf Refining Co.,
Gross St. and P. R. R.,
Pittsburgh, Pa.

Baker, C. L.,
Chief Clerk, Carnegie Steel Co. and Car Accountant, Pgh. and Ohio Valley Ry., Vance Ave.,
Coraopolis, Pa.

Baker, Edwin H.,
Second Vice President,
Galena Signal Oil Co.,
Whitehall Bldg.,
New York, N. Y.

Baker, Emmett C.,
Clerk, Union R. R.,
325 Larimer Ave.,
Turtle Creek, Pa.

Baker, J. H.,
Clerk, M. P. Dept.,
P. R. R. Co.,
207 Penna. Station,
Pittsburgh, Pa.

Bakewell, Donald C.,
Assistant Superintendent,
Duquesne Steel Fdy. Co.,
Coraopolis, Pa.

Baldwin, G. C.,
General Foreman,
Lumber Dept.,
Pressed Steel Car Co.,
McKees Rocks, Pa.

Ball, Geo. L.,
Treasurer,
Ball Chemical Co.,
153 East Ohio St.,
Millvale, Pa.

Balsley, W. T.,
Inspector, W. A. B. Co.,
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Wilmerding, Pa.

Bannister, E. J.,
Rep., Crucible Steel Co.
of America, 5621 Butler St.,
Pittsburgh, Pa.

Barker, A. E.,
Salesman,
Firth-Sterling Steel Co.,
1422 Oliver Building,
Pittsburgh, Pa.

Barnes, P. H.,
Gen'l. Car Foreman,
B. & O. R. R.,
Zanesville, Ohio.

Barney, Harry,
Secretary and Treasurer,
Laughlin-Barney Machinery Co.,
Union Bank Bldg.,
Pittsburgh, Pa.

Barron, Edward T.,
Inspection Dept.,
Carnegie Steel Co.,
671 Frick Annex,
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Barth, John W.,
Lemington Ave.,
12th Ward,
Pittsburgh, Pa.

Bartley, Milton,
President, American Nut &
Bolt Fastener Co.,
P. O. Box 996,
Pittsburgh, Pa.

Barwis, J. McC.,
Gen'l. Fore., P. C. Insp'rs.,
P. R. R. Co.,
Penna. Station,
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Basford, G. M.,
Chief Engr. R. R. Dept.,
Joseph T. Ryerson & Son,
30 Church St.,
New York, N. Y.

Basler, F. M.,
Asst. Scale Inspector,
P. R. R. Co.,
809 Fifth Ave.,
Altoona, Pa.

Battinhouse, John,
Inspector, W. A. B. Co.,
670A Middle Ave.,
Wilmerding, Pa.

Battenhouse, Wm.,
Genl. Car Inspector,
B. & O. R. R.,
Glenwood, Pittsburgh, Pa.

Bauer, A. C.,
Foreman Erecting Shop,
P. R. R. Co.,
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Baylor, H. N.,
Foreman, Penna. R. R. Co.,
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Bealor, B. G.,
Vice Pres. and General Manager,
Althom Sand Co.,
421 Wood St.,
Pittsburgh, Pa.

Beatty, E. A.,
c. o. Weston-Mott Co.,
Flint, Mich.

Beatty, E. G.,
Rep., Galena Signal Oil Co.,
Miller Park, Franklin, Pa.

Beatty, Harry M.,
Freight Conductor P. R. R.,
Elrama, Pa.

Beaumont, Clifton,
Sales Agent, Grip Nut Co.,
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Baltimore, Md.

Beebe. I. L.,
Rep. Dearborn-Chemical Co.,
1623 Farmers Bank Bldg.,
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Bellows, A. B.,
Vice Pres't., Pittsburgh
Testing Laboratory,
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Belsterling, C. S.,
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American Bridge Co.,
Frick Building,
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Beltz, John D.,
Asst. Train Master,
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Bender, F. H.,
American Steel Foundries,
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Bank Bldg.,
Chicago, Ill.

Bengnot, J. J.,
General Foreman,
Pennsylvania Co.,
Alliance, Ohio.

Benner, Samuel A.,
Gen'l. Mgr. Sales,
Carnegie Steel Co.,
Carnegie Bldg.,
Pittsburgh, Pa.

Bennett, H. W.,
Clerk, Penna. R. R. Co.,
Penna. Station,
Pittsburgh, Pa.

Bennett, R. G.,
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Altoona, Pa.

Berg, Karl,
Draftsman, P. & L. E. R. R.,
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Berghane, A. L.,
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Brake Co.,
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Bernard, R. Y.,
Railway Supplies,
Land Title Bldg.,
Philadelphia, Pa.

Beswick, John,
Ass't. Road Foreman of
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Bigelow, Harry T.,
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Bihler, L. C.,
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Carnegie Steel Co.,
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Draftsman P. S. C. Co.,
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Billingham, R. A.,
Supt. M. P.,
P. S. & N. R. R.,
St. Mary's, Pa.

Binns, J. Y.,
Special Agent,
Monongahela R. R. Co.,
Brownsville, Pa.

Blackall, Robt. H.,
Railway Supplies,
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Blair, Harry A.,
Div. M. C. B.,
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Blakley, T. M.,
R. F. of E., Penna. R. R.,
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Bleasdale, Jas.,
Supervisor Air Brakes,
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Blest, M. C.,
Mechanical Engineer,
Western Steel Car &
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Hegewisch, Ill.

Boenig, Geo. C.,
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General Agent,
San Pedro, Los Angeles
and Salt Lake R. R.,
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Bole, Robt. A.,
Manager, Manning,
Maxwell & Moore,
Room 1005, Park Bldg.,
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Bond, W. W.,
Asst. Road Foreman of
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Booth, Arthur,
Ass't. Gen'l. Pur. Agent,
Philadelphia Co.,
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Booth, J. K.,
Genl. Fore., B. & L. E. R. R.,
No. 8 Penn Ave.,
Greenville, Pa.

Booth, Jas.,
Rep., Midvale Steel Co.,
Oliver Building,
Pittsburgh, Pa.

Bottomly, E. S.,
Chief Joint Inspector,
B. & O. R. R. Co.,
Martinsburg, W. Va.

Boyer, Chas. E.,
Gen'l. Car Inspector,
P. R. R. Co.,
Room 204 Penna. Station,
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Boyer, John B.,
Loading Expert, Bridge Dept.,
The Penna. Steel Co.,
Steelton, Pa.

Boyle, H. Edgar,
Chief Clerk, Car Record Dept.,
Penna. Lines West of Pitts-
burgh, 1013 Penn Ave.,
Pittsburgh, Pa.

Brady, Daniel M.,
President, Brady Brass Co.,
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Brandt, E. K.,
Ass't. Train Master,
Penn'a R. R.,
Penna. Station,
Pittsburgh, Pa.

Branson, Craig R.,
M. P. Inspector,
Pennsylvania Co.,
302 West Berry St.,
Fort Wayne, Ind.

Brantlinger, J. H.,
Engineman, P. R. R.,
226 Miller St.,
Mt. Oliver, Pittsburgh, Pa.

Braun, A. C.,
Asss. Sup'r Signals, P. R. R.,
847 N. Linden Ave.,
Pittsburgh, Pa.

Breese, E. W.,
Car Lighting Foreman,
Penna. Lines West,
1741 Buena Vista St.,
N. S., Pittsburgh, Pa.

Brennan, E. J.,
Master Mechanic,
B. R. & P. Ry.,
DuBois, Pa.

Bretz, F. K.,
General Manager, Morgantown and Kingwood R. R.
Morgantown, W. Va.

Brewer, Wm. A.,
Mechanical Engineer,
Standard Ry. Equip. Co.,
Frick Bldg.,
Pittsburgh, Pa.

Brewster, Morris B.,
Rep., U. S. Metallic Packing Co., 6040 Jefferson Ave.,
Chicago, Ill.

Briggs, Ira Otis,
Train Dispatcher,
Pittsburgh Division,
P. R. R. Co.,
Penna. Station,
Pittsburgh, Pa.

Briggs, Templeton,
Assistant Chief Inspector,
Carnegie Steel Co.,
Schoen Steel Works,
McKees Rocks, Pa.

Brooks, Walter A.,
Asst. Foreman Boiler Shop,
Penna. Co.,
3211 East St.,
Pittsburgh, Pa.

Brower, R. M.,
Rep., American Brake Shoe & Foundry Co.,
30 Church St.,
New York, N. Y.

Brown, A. D.,
C. C. to Genl. Manager,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Brown, Alexander M.,
General Manager,
Zug Iron & Steel Co.,
Thirteenth and Etna Sts.,
Pittsburgh, Pa.

Brown, D. S.,
Clerk, P. R. R.,
814 So. Soles St.,
McKeesport, Pa.

Brown, E. C.,
Chief Civil Engineer,
Carnegie Steel Co.,
Room 1122,
Carnegie Bldg.,
Pittsburgh, Pa.

Brown, J. Alexander,
Vice Prest. and Mgr.,
The Railway Equipment & Publication Co.,
75 Church St.,
15th Floor,
New York, N. Y.

Brown, J. F.,
Fairbanks Co.,
29th and Liberty,
Pittsburgh, Pa.

Brown, John T., Jr.,
Supt. Duquesne Reduction Co.,
Gross and Yew Sts.,
Pittsburgh, Pa.

Brown, L. M.,
Salesman, McKenna Bros.,
107 Virginia Ave.,
Mt. Washington,
Pittsburgh, Pa.

Brownscombe, G. J.,
Clerk, Union R. R. Co.,
Port Perry, Pa.

Brunker, A. R.,
General Sales Agent,
American Steel Foundries,
36th and A. V. Rwy.,
Pittsburgh, Pa.

Brunner, F. J.,
Auditor, Wabash Pgh. T. Ry.,
521 Wabash Bldg.,
Pittsburgh, Pa.

Bucher, C. A.,
420 Pacific Ave.,
Pittsburgh, Pa.

Buckbee, W., A.
Slingerlands, N. Y.

Buckley, Wm.,
Welding Engineer,
Davis Bournonville Co.,
90 West St.,
New York.

Buechner, W. A.,
District Manager,
E. F. Houghton & Co.,
615 Fulton Bld.,
Pittsburgh, Pa.

Bugle, Geo.,
Asst. R. F. Engines,
Penna. R. R. Co.,
346 Miller St.,
Mt. Oliver, Pittsburgh, Pa.

Buffington, W. P.,
C. C. to Supt. Trans.,
Pittsburgh Coal Co.,
Hussey Building,
Pittsburgh, Pa.

Bulkley, B. M.,
Rep., Greene, Tweed & Co.,
8 Elsinore Apt., Craft Ave.,
Pittsburgh, Pa.

Burke, William,
Assistant Yard Master,
Monon. Conn. R. R.,
405 Oakland Ave.,
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Burns, J. D.,
Salesman, Crucible Steel Co.,
1919 Oliver Bldg.,
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